THE BIRTH AND DEVELOPMENT OF THE AMERICAN SUBMARINE

FRANK T. CABLE

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BY

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CONTENTS

CONTENTS

CONTENTS

CONTENTS

ILLUSTRATIONS

Publishers' Foreword

This timely book is published to meet the demand in all the countries of the world for accurate information regarding the *future of the submarine*—and its direct effect upon the future of war and world peace.

What is the submarine? Is it a "sea devil" that threatens the existence of nations? Or is it a little God-send in disguise that will drive age-long war from the seven seas, make great naval battles impossible, and ultimately force *the era of world peace which all humanity seeks?*

These are some of the questions that disturbed the Washington Conference and that create discussion in the inner circles of the League of Nations. What shall we do with the submarines? Shall we chain them to our ports like watch-dogs of defence *to protect us from* invasion? Have the great navies seen their last days?

While volumes have been published on various phases of this subject, this is the first book to go down into the depths of the situation and reveal the true story of this most ingenious invention of mankind.

The publishers, in seeking sources for the facts herein presented, have made a real discovery. We have found *an old submarine* "sea dog" who knows the whole inside story of this modern miracle, who joined the first crew twenty-five years ago.

Capt. Frank T. Cable is one of the few living experts on the naval submarine. He lives in the old shipping port of New London, Connecticut, where almost since the founding of America, "men have been going down to the sea in ships."

Captain Cable is the electrical engineer who helped to develop the original Holland submarine, commanded her on every trip until she was sold to the United States government twenty-four years ago. He superintended the completion, conducted trials and trained the crews for the first submarines built by the English, Russian and Japanese governments. He has spent nearly thirty years in the development, construction, and operation of these undersea craft, and in connection with this work has visited every country in the world that has adopted submarines.

This volume, therefore, is in the nature of an official document that will prove a revelation to those who otherwise would never know the inside facts regarding one of the momentous problems among the nations today.

The Captain's Log

My intent in setting down these calculations on my first journey underseas is not so much to develop a narrative of adventure, as it is to clear up the mystery that engulfs *one of the greatest human achievements* and to give historical credit to the genius who gave his life to its accomplishment.

The submarine is an American invention—it is the genius of an ardent Irish-American patriot. It belongs to America—with the telephone, the telegraph, the steamship, the airplane, electricity, and the other wonders of the modern world that have marked the beginning of new epochs.

As Kipling said, "I learned about women from 'er," in speaking of his little Bengalese, so the Germans must admit in their own consciences, "What I know about submarines I learned from him"—speaking of my Irish-American comrade, friend, and fellow-worker, *John P. Holland.*

Perhaps I am sailing into dangerous waters with this volume—there may be sunken mines ahead—but I have seen many a hazardous voyage, and whatever the odds may be, I have but one port ahead, and that is to take John Holland to his *final resting place* in the pages of history. I do not intend to see him robbed of the honors that are due him, or to see him suffer for the misdeeds and diabolical devices of others who may have "misappropriated his brains" and used them against the laws of honorability in war—even though it be granted that "all is fair in love and war."

The facts that I am to relate are taken from *private diaries, records, personal experiences, conversations and confidences,* covering twenty-five years, supplemented by extensive research and investigations of The Search-Light Organization, New York. I know what John Holland intended to do when he gave his life to the development of the submarine. I know the services he intended to render to his country and to the world. And I know that the impelling motive behind him was his almost fanatical belief that the submarine would make naval wars impossible, and that this eventually would *lead to disarmament on both sea and land, until war* is abolished from the human race.

My duty requires me to deal with motives as well as men and mechanics; with governments and statecraft as well as invention. It leads into the world's capitals as well as its ports, and, paradox that it may seem, the greatest battles of the submarines have so far been fought in the closeted committees of *legislative bodies, congresses, and parliaments.* While I am neither a trained writer nor an historian, I trust this volume may to some degree perform its mission.

F. T. C.

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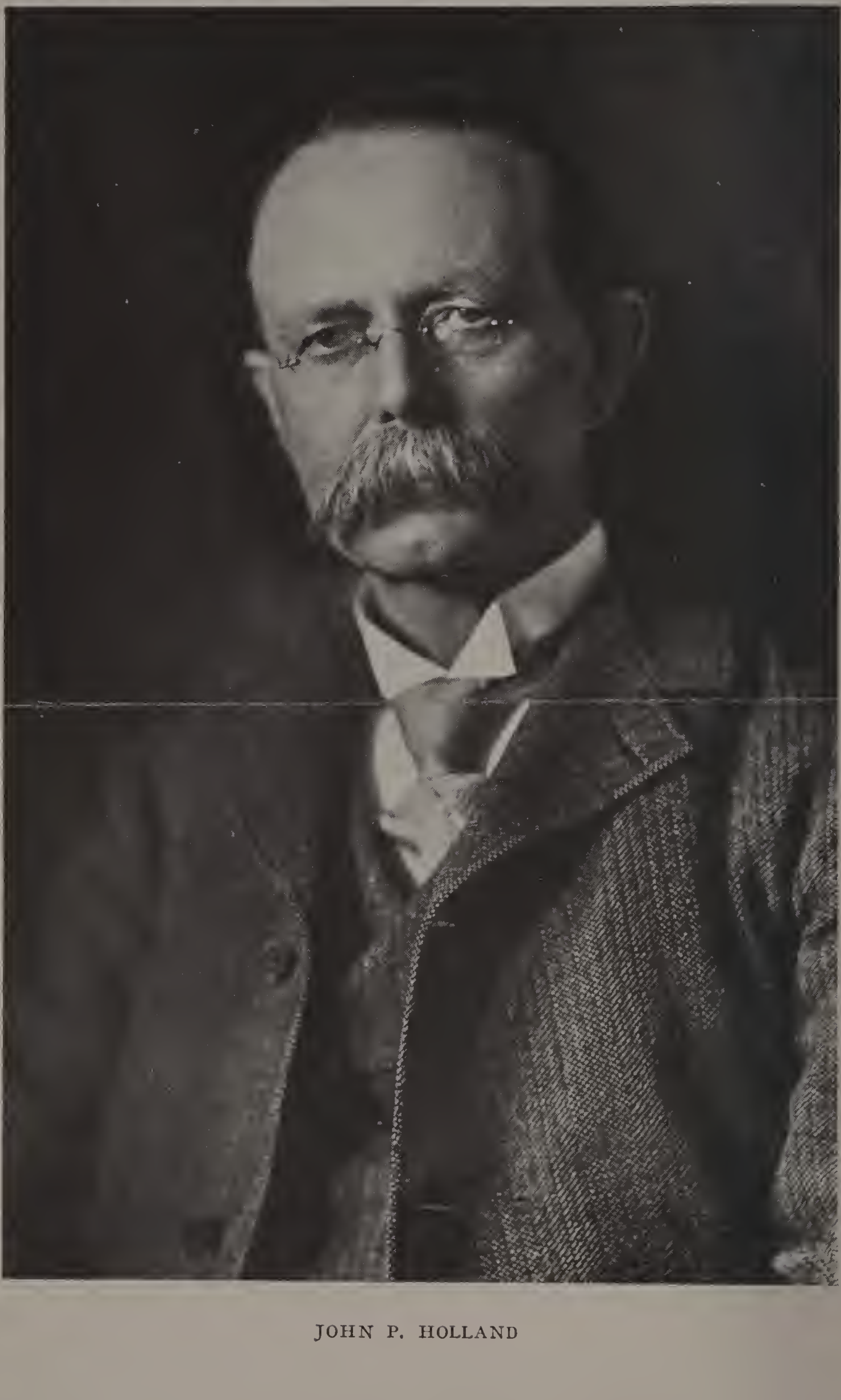


JOHN P. HOLLAND

CHAPTER I

The submarine's mission.—Development synchronized with growth of war symptoms.—British objections to its continued use.—American attitude on humane warfare. — Disarmament Conference's conclusions. — Upheld as a legitimate war weapon.—Sims's defense of its operations.—Submarine restraints on naval strategy. —Not yet tested as a fighting force against war vessels.—Its toll of British naval craft linked with Holland's original purposes in studying undersea navigation.

THE evolution of the modern submarine from the crude devices of its infancy received its main impetus from the brain of an Irish-American, John Philip Holland, in the 'seventies of the nineteenth century. Hence its vicissitudes toward the goal of practicality are largely interwoven with the adventurous youth of the world-famed type of boat identified with that inventor's name, and with which this narrative mainly deals.

The subject extends far beyond the beginnings of the Holland craft, because from that type Germany evolved her ravaging U-boats, and in her methods of using them covered the new weapon with infamy. The subject inevitably extends to the submarine's ends. What are they? As the Disarmament Conference at Washington disclosed, the use of undersea craft as war weapons became an undetermined dispute between Great Britain and the other leading powers (including the United States), who shared in that conclave.

The World War showed what the submarine could do. Its performances were also interpreted as revealing what it could not do. Of more moment to the world than either was the agreement of the Conference regarding what it should not do, for upon a moral and humane restriction of its activities rests the survival of the submarine as a useful naval arm.

Coming into its own in the World War, the submarine more than realized the claims Holland made for his great contribution to its development. The war provided an intensely dramatic justification of his wildest dreams. Their realization was startling and horrifying enough, and took a direction neither he nor other submarine pioneers intended. Germany misused the new weapon, but the crime was not the submarine's. Nevertheless, both the submarine's appearance and Germany's misbehavior were inevitable. By 1914 undersea navigation had fully emerged from its long adolescence and was ready for the supreme test. Germany, whose morality or mentality, as Admiral Sims put it, dictated the character of the war, on sea no less than on land, could not act other than she did. Perhaps an ironical direction of fate can be discerned in the fact that the war, which cast its shadow over Europe long before it came, did not break before the submarine was ready. As the war symptoms became more and more acute, the submarine advanced in efficiency. It moved toward maturity synchronously with the swelling of the undercurrents of national antagonisms that caused the conflict. The war could almost be said to have waited until the submarine spoke the word.

Germany pounced on the new arm to rescue her sea campaign from being wholly sterile, with the result that undersea craft came under drastic indictment at the Washington Conference. Great Britain, through her chief spokesmen, Lords Balfour and Lee, sought to extirpate the new weapon root and branch. They charged that it had accomplished little in legitimate warfare. Germany, with a fleet of 375 boats, aggregating 270,000 tons—the figures are Lord Lee's—had shown that its main use lay in the destruction of commerce. The most ardent of submarine advocates will concede the substantial grounds Great Britain had for regarding the submarine solely as a merciless pirate in view of the wholesale holocausts her merchant fleets suffered at Germany's hands. The British were naturally blinded by their maritime losses; also, they did not want their great naval squadrons to be at the mercy of other nations' submarines. Not content with even a limitation of modern craft, they were ready to scrap their own efficient submarine fleet of 82,000 tons, despite the possession of long coast lines needing protection, if other powers would do the like. With limitation a submarine fleet could be rapidly augmented in time of war. They rightly held that submarines could only be built if the industry were kept alive, and an adequate personnel could only be provided if a trained nucleus already existed. Hence the menace of submarines could only be removed by their complete abolition.

The British case is worth stating, not alone on humanitarian grounds, but for the rebuttals it evoked. The United States, France, Japan, and Italy alike defended the continued use of submarines, especially for coast defense. American feeling was voiced by the Advisory Committee which aided the United States delegation. This committee, headed by an admiral and composed of representative men and women from all fields of activity and all parts of the country, reflected every shade of public sentiment. Though Secretary Hughes told the Conference that their conclusions were not submitted as expressing the opinions of the government, there can be little doubt that the administration was in accord with them. It had this to say regarding brutal methods:

"The United States would never desire its navy to undertake unlimited submarine warfare. In fact, the spirit of fair play of the people would bring about the downfall of the administration which attempted to sanction its use. . . . The committee is therefore of the opinion that unlimited warfare by submarines on commerce should be outlawed. The right of visit and search must be exercised by submarines under the same rules as for surface vessels."

After the Conference had threshed out the subject, Admiral Wemyss, for Great Britain, further challenged the utility of submarines as commerce destroyers in the *Nineteenth Century* in discussing the effects of the naval limitation treaty. He submitted that their lack of means for providing for the safety of the crews of the vessels seized was in itself sufficient to make them useless for this purpose unless the illegal and inhuman practice of sinking without warning was resorted to. His conclusion was that as a commerce destroyer the submarine was, "if legitimately used, practically useless."

Admiral Wemyss here echoed the feeling of the Conference that conditions of submarine warfare made impossible the observance of humane laws. But his flat statement that submarines were useless as legitimate commerce destroyers found a challenger in Admiral Sims. This sturdy American champion of efficient and legitimate navalism declared that the evidence to the contrary was overwhelming.

"The success of the German submarines in attacking allied merchant shipping, and the subsequent success of the allied navies in protecting this shipping in convoys," he said in "*Current History*," "were both due to the simple fact that the geographical situation was such that the bulk of the shipping had to converge to pass through the English Channel or the Irish Sea; the submarine (except a few cruising subs) could not operate more than about three hundred miles to the westward of these channels, because further out the dispersion of the shipping would have been so wide that they could have sighted but few vessels. This inevitable restriction of the submarine's operations within this limited area made it possible for the destroyer forces, based on Queenstown, Brest, and the western Channel ports, to protect the convoys in their passage through this area—the so-called submarine danger zone. That is, the destroyers were able to do this because the distances they were required to steam from their bases of supply were not beyond their radii of action at the speed required for this service. Manifestly, such service could not be performed outside the radius of action of the escorting vessels.

"This is one of the reasons for the inhumane method of submarine warfare as practiced by the Germans. In waters close to their bases, the smaller, short-radius submarines could also operate, but the attacked craft could generally summon aid if warned. This meant that the torpedo was generally relied upon under these conditions.

"The other reason was, of course, that the Germans believed in and practiced terrorism as a part of their war philosophy. In Belgium the results were rather satisfactory: German communications were rendered secure with a minimum of troops. This fact does not condone the practice of terrorism, but it does indicate that inhuman methods were not so much a necessary part of submarine war as of German war methods. For example: there is no inherent quality in the submarine that makes the gunning of survivors in lifeboats—an unproved charge, by the way—necessary and the employment of submarines did not force the Germans to sink hospital ships."

Out in the open sea, beyond the immediate danger of meeting anti-submarine craft, German methods were different. There they employed cruising types of submarines, and the freer surroundings enabled more humane conditions to be observed. The larger tonnage, wider range, greater speed and gun power of the German cruising submarines admitted of different tactics from those followed nearer the destroyer-infected British and French coast waters. Thereon Admiral Sims remarked:

"To sink by torpedo, without warning, was unnecessary, costly, and inefficient. Only a limited number of torpedoes could be carried. To capture by threat of gun fire and to board and use a bomb were not only more effective, but more economical. On the other hand, to capture conferred other advantages. Stores could be taken, the captured ship could be used as a base, and part of the crew rested and become refreshed as a prize crew, and when the passengers and crews of other ships that had been sunk filled the prize she could be freed to proceed to port. This was actually done. The *U-140* carried a special prize crew. The *U-156* captured the Canadian trawler *Triumph,* armed her and used her as a raider. The same submarine captured the schooner *Willie G.* and set her free with the crew of the British steamer *Eric,* who had been prisoners on the U-boat.

"In short, the modern cruising submarine, because of its size, radius, speed, and armament, is a more efficient cruiser than any surface type possibly can be, because it can keep the sea longer and can conceal itself at will. If it resorts to inhuman methods, it is not because its limitations force it to do so, but because it prefers such methods."

The cruising submarine, Admiral Sims concluded, could be used continuously and effectively against an enemy's commerce and With few exceptions, the German cruising without any violation of international law.

submarines were so used during the war. However, their employment was not extensive —the type, in fact, did not appear till the war's final stages. Their more humane operations, accordingly, were far outweighed by the depredations of the smaller types, which held the field for most of the war period. The five powers which considered the subject at the Conference were aware only of the latter's behavior and condemned it. They adopted the Root resolution, which went farther than prescribing laws governing the seizure and sinking of merchant vessels by submarines and safeguarding the lives of neutrals and non-combatants. While naming these laws, the resolution vitiated them in declaring that submarines could not be used as commerce destroyers without violations. Hence in agreeing on the laws to be respected, the five powers despaired of their observance. So the resolution's real purpose, affirmed by these powers at the Conference, aimed at prohibiting submarines making war on helpless commercial vessels altogether. Therein lay a signal victory for Great Britain. Short of encompassing the abolition of submarines, she was well content, with the other powers, to have their operation restricted to war vessels.

Here we enter on the real field of the submarine—the objective of Holland and other inventors. Great Britain's case for complete abolition necessarily embraced a denunciation of the submarine's value as a legitimate war weapon, but here the British stand, especially as stated by Lord Balfour, was at its weakest. The submarine, both he and Lord Lee insisted, was not even an arm of the weak; it failed in coast defense, a contention that lacked conviction in view of Great Britain's own earlier policy in adopting submarines primarily for that duty. The British were not on much more solid ground in maintaining that the submarine's value had already been reduced by the employment of swift vessels, powerfully armed and equipped, to resist underwater attacks, and of new methods of detecting the submarine's presence and forestalling its offensive power. Much has been done in this direction, but it is not true that means of destroying the submarine exceed its strength as a war weapon. As methods of its operation develop, so will its power of attack increase.

Searching for more ammunition with which to riddle the case of the submarine, the British spokesman hit upon one statement advanced that the submarine was cheap and therefore serviceable for poor nations. Lord Lee hoped—as we all do—that the Powers did not want to make war cheap; when war was cheap it had been almost continuous. He objected to the submarine being defended because it was deemed to be a weapon within the reach of all countries. It was a good point to make; but submarines are not cheap to those nations who need them most—those with long coast lines. The submarine of to-day is no longer lilliputian and inexpensive to build. It has great cruising and armament power, a rising tonnage, and endless potentialities for an expansion in bulk and equipment that will rank it with costly surface vessels of considerable displacement.

The submarine's service in war was convincingly stated by the American Advisory Committee:

"Against enemy men-of-war, the submarine may be likened to the advance guard on land which hides in a tree or uses underbrush to conceal itself. If the infantry in its advances encounters an ambuscade, it suffers greatly even if it is not totally annihilated."

"However, an ambuscade is entirely legitimate.

"In the same fashion, a submarine strikes the advancing enemy from concealment, and no nation cries out against the form of attack as illegal. Its navy simply becomes more vigilant, moves faster, and uses its surface scouts to protect itself. . . . The best defense against them is eternal vigilance and high speed. . . .

"The submarine as a man-o'-war has a very vital part to play. It has come to stay. It may strike without warning against combatant vessels, as surface vessels may do also, but it must be required to observe the prescribed rules of surface craft when opposing merchantmen at other times.

"As a scout the submarine has great possibilities. It is the one type of vessel able to proceed unsupported into distant enemy waters and maintain itself to observe and report enemy movements. It has great value, a legitimate use, and no nation can decry its employment. . . .

". . . Submarines acting legitimately from bases in our distant possessions would harass and greatly disturb an enemy attempting operations against them. They might even delay the fall of these possessions until our fleet could assemble and commence major operations.

"It will be impossible for our fleet to protect our two long coast lines properly at all times. submarines located at bases along both coasts will be useful as scouts and to attack any enemy who should desire to make raids on exposed positions.

"The submarine is particularly an instrument of weak naval powers. The business of the world is carried on upon the surface of the sea. Any navy which is dominant on the surface prefers to rely on that superiority, while navies comparatively weak may but threaten that dominance by developing a new form of attack to attain success through surprise. Hence submarines have offered and secured advantages until the method of successful counter-attack has been developed.

"The United States navy lacks a proper number of cruisers. The few we have would be unable to cover the necessary area to obtain information. Submarines could greatly assist them, as they cannot be driven in by enemy scouts.

"The retention of a large submarine force may at some future time result in the United States holding its outlying possessions. If these colonies once fall, the expenditure of men necessary to recapture them will be tremendous and may result in a drawn war which would really be a United States defeat. The United States needs a large submarine force to protect its interests."

Lord Balfour's case against the submarine's war value savored of the contentions of an advocate speaking solely by his brief. Even British naval opinion did not support him. Where, asked Admiral Wemyss, was his authority for stating that only as a commerce destroyer had the submarine been successful?

"The claim," said this British naval officer, "that the efficacy of these vessels is based on their successes obtained in commerce destroying is incorrect, for their successes in that line were solely due to the illegality of the way in which they were used. To presume that this in future will be the sole method of their employment is to attribute to those who believe in submarines a mentality for which there is not the slightest justification.

"When the war broke out the submarine was an untried weapon. That the Germans at first hoped by its means materially to reduce the superiority of the Grand Fleet is known; that they failed in their object was less due to the inefficiency of the weapon than their want of experience in its use. To deduce from this that it has no offensive value is to ignore the deeds of our own submarines in the Baltic and in the Sea of Marmora.

"Who, with the lessons of the Dardanelles campaign before him, can say that they are useless as a weapon of defense? Had any been present off Gallipoli in April, 1915, the landing of the troops on the peninsula would have been impossible; never could the transports and supply ships have lain quietly off those beaches, pouring forth men and munitions as they did, had they been open to submarine attack. As it was, when they did, later on, make their appearance, they sank two battleships and drove the transports into the security of Mudros Harbor, thus increasing enormously the labor and difficulty of keeping the army supplied.

"Submarines have rendered a close blockade impossible, and the duties they carried out in the North Sea, watching the enemy coasts, have proved them to be a most valuable adjunct to the main fleet."

It is pertinent to point out, however, as Admiral Sims has done, that in the World War the submarine never really received its baptism of fire as a fighting vessel—that is, matched against other war vessels. No organized and concerted submarine attack was ever tried. The submarine's main strength was concentrated against merchant shipping. Its sinkings of naval craft were incidental, but, though small, were hardly negligible. That German craft rarely attacked allied men-of-war could not be construed as showing the failure of submarines as weapons of legitimate war. The cause of German abstention was well stated by Admiral Sims:

"Assuming the decision of the German Admiralty to violate the laws of humanity and international law, their submarine campaign was strategically sound. A determined submarine attack upon the vessels of the Allies would doubtless have been reasonably successful, but the loss of submarines would have been considerable, and it would have been risking a great deal to have assumed that the submarines could have sufficiently weakened the Grand Fleet before too many of their number had been destroyed. Therefore the German naval authorities acted upon the much safer, and I believe sounder, decision to avoid a costly 'frontal' attack in favor of an attack upon the Allies' wholly essential sea lines of communication, that is, the merchant shipping—a most inviting objective, considering the fact that this shipping was very inadequately protected at the time the intensive submarine campaign was decided upon.

"However, as it is a fact that the submarines systematically avoided action with men-of-war, except in the few cases where they believed they were sure of a killing, it is apparent that the record the submarines made in such attacks against men-of-war does not justify the conclusion that these results are a measure of what submarines are capable of doing in organized attacks against naval forces."

Just what, then, did the submarines do against fighting vessels? Their outstanding achievement was the part they played as a deterrent to the free movements of surface war craft. If they did not wholly keep the Grand Fleet at bay, they at least dictated its tactics. The fleet's safety was only assured by its heavy screen of cruisers and destroyers, and by zigzagging at high speed, but its chief safety lay in its nearness to supply bases. Such protective formation and methods of navigation could not have guarded the fleet for long against submarines if it operated far from its bases, say, 2,000 or 3,000 miles distant, for the vessels could not steam and zigzag far at high speed, and their destroyer escort had a still more limited radius of action.

Fighting ships need to be within proximity of their bases to foil submarine attacks, and their success even then is not assured. A British fleet, say in American waters, with all its power based on its home ports, could not effectively blockade New York harbor, the Delaware, and the Chesapeake in face of the presence at these ports of adequate submarines; it would equally fail to maintain itself before a South American or any other distant port.

Able to go where they pleased, the submarines during the war, except in waters closely guarded, limited the radius of action of a fleet. They barred surface vessels from remaining in any area where the water was deep enough for submerged operations. As checkmates to a close blockade, as coast vigilantes, the submarines reached a high mark of effectiveness, as Admiral Wemyss noted. Blockading Heligoland Bight at close range caused the torpedoing by submarines of so many men-of-war that the Allied effort was abandoned. The region could only be blockaded at long range, and then not wholly, by surface vessels guarding the north and south entrances of the North Sea far enough away from German submarine bases to make the blockaders relatively safe from attack. It was not the mine fields that kept the Allied war craft a respectful distance from the German coast. Admiral de Bon, speaking for France, told the conference that if Germany had maintained her coast intact, it was not solely because of her barrier of mines. This protection could have been overcome by any naval force provided with mine sweepers, had not watchful submarines, supplementing the mine defenses, rendered approach to them dangerous.

Submarines likewise achieved what Holland himself had declared was impossible, but then, as the narrative to be unfolded will show, they developed far beyond his early conceptions. They fought submarines. It was here that Allied undersea craft played a distinctive part. Admiral Sims in his *Victory at Sea* noted that in proportion to the number of the various types of anti-submarine craft employed, the Allied submarines destroyed three times as many German submarines as the Allied destroyers, and twenty times as many as the auxiliary patrol craft.

The destructive record of both Teutonic and Allied submarines against naval vessels has been roughly calculated at 131 vessels, which embraced battleships, battle cruisers, cruisers, gunboats, destroyers, submarines (30), auxiliaries, and other craft. Great Britain, of course, bore the greatest loss, namely, 60 vessels; France came next with 23. Germany lost 13 naval craft, in addition to 20 submarines, through Allied undersea operations; Austria lost 10; Turkey 8. The American loss by submarines was small—one destroyer and two auxiliaries. As a "side line" of the submarine's performances in the war, its naval record disposed of the contention that it was weak as a legitimate fighting weapon.

British naval losses from undersea warfare are especially of note in relation to the subject of this narrative, for they form an historic link with the beginnings of the modern submarine and the purpose which inspired Holland's invention. The war, moreover, produced an episode that had a closer connection. This was the visit to the Irish shore in 1916 of a German U-Boat bearing Sir Roger Casement on his mission to perform his part in wresting Ireland from British rule. The event had a significance which war commentators did not perceive. It had a direct bearing—somewhat remote in time, it is true, forming as it did a gap of fifty or more years—upon the ambition which animated Holland as an Irish youth in turning his thoughts to underwater navigation.

Had he been living to witness the appearance of that U-Boat off the coast of Ireland, he would have recognized it as more than a symbol of the fruition of the dream which eventually was to take material shape in American shipyards.

CHAPTER II

Holland as an Irish teacher—Birth of his submarine device.—His calling and hobby in conflict.—Crude devices of the past as a guide.—The *Merrimac's* exploits in the Civil War against wooden ships and her fight with the *Monitor* stimulate his submarine studies.—Ironclad fleets foreseen as a result.—Strengthening of British naval supremacy by this development.—Consequent need of undersea weapons to curb the power of dreadnaughts.—Holland's hostility to England a directing influence in formulating submarine devices.—Aimed to weaken British sea power.

The father of the modern submarine sprang from the Irish peasantry, a stock which has produced many noteworthy men of the Emerald Isle. His early days were passed in the obscure little town of Liscannor, in County Clare on Munster's western shores, where he was born on February 24, 1842. If early associations mold a man's mind, Holland had an element at his very door that must have exercised a formative influence upon his boyhood. It was the sea, and, with the sea, ships. He was born in sight of a shipyard on Liscannor Bay, and the Atlantic roared beyond. At the early age of six he had mapped his future.

Liscannor was as good a breeding place for ideas as anywhere else. Genius bloweth where it listeth, and nature does not select prepared locations for its nourishment. The town was no more than a village on a bay; even to-day it numbers only a few hundred inhabitants. Greater and lesser men than Holland have had beginnings as remote and, on the surface, as unpromising. His early boyhood was merged with his surroundings; he was lost in them, undistinguishable from the youth he mingled with.

What primary education he received was imparted by the Christian Brothers at a school in Limerick, where the river Shannon flows, some forty miles to the southeast across his native county. There, at the age of fourteen, he showed the first symptoms of his native bent. He passed an examination in navigation. His inclinations had definitely turned to the sea, and he looked toward seamanship, or work in a shipyard, as his ultimate lot. But a physical disability intervened. He was near-sighted. His vision was so defective that, as he said in later days, "no one would trust me even to row a two-oared boat, much less to navigate a ship." The shipping industry had no more use for near-sighted mechanics than it had for sailormen who could not see straight. He was compelled to remain at school, but not as a pupil. The first Holland submarine was conceived in a school by a mind that knew very little about it.

At the beginning of the century a noted German naval expert, Carl Bushey, complained before a meeting of the German Society of Naval Architects and Naval Engineers that of all branches of ship construction, the ignorant had devoted the most of their energy to the designing of submarine boats. Researches in the German naval archives from the year 1861 showed no less than 181 different plans whose designers were in all branches of business except that of ship construction. They included ministers, teachers, students, bank clerks, and other people in the peaceful walks of life, including simple mechanics. This was equally true of other countries. Interest in undersea navigation was almost wholly confined to landsmen. Shipbuilders and designers paid little attention to the subject.

Holland was a landsman and a teacher. His defective eyesight seemed to have determined his calling. He would have been the first to acknowledge that in his early days he came under the classification of ignoramuses who dabbled with ideas beyond their grasp. The difference between him and the other experimenting landsmen was that his ideas eventually came within his grasp. Years later an American engineer, in describing Holland's achievements, referred to him as a man "with but little education, but of bright mind." The latter statement presented the leading fact about Holland. His bright mind overshadowed his lack of education.

Learning has been known to destroy bright minds, and Holland preserved his by discarding it. His genius dispensed with culture; his schooling came from a workshop and harbor waters. In fact, his occupation as a teacher—he taught school for twenty-one years, from 1858 to 1879, both in Ireland and in the United States—was unfavorable to the development of his mechanical bent. The opportunity presented itself for a scholastic career; at least channels were open to him for the acquisition of a general culture which perhaps would have ranked him eventually with the learned élite. College degrees were ahead of him, had he sought them. One could readily picture him, with the educational background of his early years, as graduating toward a professorship, or as principal of a high school. But he passed by the deeper founts of book learning. His capacity as a teacher was based on what educational facilities were immediately open to him, and restricted to the requirements of the various schools that employed him. He was content to impart elementary knowledge to elementary pupils, and as a pedagogue he did not advance beyond that grade. His mind had other things to do. This is to say that Holland was not a success as a teacher.

Natural science came easy to him, as well as draftsmanship and mathematics, being subjects that appealed to his mechanical turn. As a teacher at the North Monastery Schools of the Christian Brothers in Cork, he had a directing influence in Brother Burke, who enjoyed a high repute in Ireland as being in advance of his time as a teacher of science. This was in the 'sixties of the last century, when Holland was in his early twenties. By the outlook his occupation was closing in round him, determining his future. He followed it in Drogheda and in Dundalk. He seemed farther off than ever from his real field. In Dundalk he found himself drawn into the study of music. Consider the inventor of the modern submarine wielding a bâton in directing a choir. He had the distinction, such as it was, of being the first person in Ireland to teach music according to the Sol-fa system, and the choristers he trained were a credit to him. Sighting blue water under sea through a periscope was a long way off. The waters round New York, where he was to have so many adventures with the primitive contraptions that paved the way to greater things, were no less distant. But his imagination, without his being consciously aware of its gropings, was spreading out lines that were later to take him where he belonged.

His aptitude for invention at this time diverted his mind from his irksome occupation. His leisure produced dreams of submarines, clocks, and flying machines. These mental excursions into the realm of abstruse mechanics showed that, while looking for his path, he had not yet found it. In pursuing them he got far afield from his true *métier*. His first contrivance took his mind up into the air instead of under the sea. It was the model of a flying machine; its fate, though unknown, was not in doubt. Oblivion took care of it. It was a little early for the airship, which did not rise full fledged till fifty years later.

Holland, in the then immature stage of his inventive powers, was plainly in need of direction. He could readily dabble in primitive devices to exerise his mechanical bent. The pastime was not wholly fruitless; he produced playthings to exercise his imagination, but, inventor-like, he took his creations seriously, and he was laughed at for his pains. Guidance as to the whence and whither of his mechanical studies was not available. No one was interested. A man's dreams must fructify of their own volition, motivated by the dynamics of the mind that produces them, but their first need is external stimulus. Holland found no incentive at hand. Moreover, the adventures of submarine inventors in the past had been dismal failures when they were not tragic.

Despite this outlook, he cast about for guiding principles upon which to formulate an undersea craft applicable to modern sea conditions. An extensive field was presented. Man's rude efforts to hold his own beneath the waves by devising all manner of strange devices reached back far into the mists of history.

The primary idea that animated early inventors was to remain under water and breathe as freely as if above the water. The germ of a submarine was evolved when they succeeded in devising a vessel containing air and large enough to hold a diver. The beginnings of the modern undersea craft became the more pronounced by the provision of means of propulsion, however crude. The devices took many forms, among them diving bells, cylinders, leather boats, air-tight boxes, arks, hogsheads, barrels with pointed cones, and one had a metal hull, spindle shaped, to allow of progress in either direction.

The first advance from the early diving apparatus (Aristotle mentions diving bells used in a siege of Troy, 332 B. C.) was the water-tight glass barrel, raised and lowered by chains, in which Alexander the Great is said to have descended to the sea bed and there sat comfortably defying a whale. The story, if not true, was at least instructive. The idea produced, in 1400, a design of a boat in the form of a cylinder with a pointed prow and stern, both detachable. It was intended to cross rivers without being seen by an enemy. Leonardo da Vinci about 1490, among his other ingenuities, evolved an undersea device shaped as a rigid tube, and in 1538 a notable diving bell was tried out in Toledo, Spain.

These instances belong to the records and nowhere else. Among such crudities of the past, however, were two contrivances that may well have served as guideposts for Holland's more immediate predecessors. One was credited to the Scandinavian pirates who infested Greenland in the sixteenth century. They used leather boats, which they navigated, "not so much above as under the water," as the records went, and crept in ambush under merchant ships and bored holes in the hull below the pumps. The idea is not far removed from Bushnell's device for attaching a torpedo under a vessel by means of a screw. The other development was a submersible invented by a Dutchman, Cornelius van Drebbel, in 1620. His boat, of which he made several, was made water-tight by oiled leather stretched over the outside wood. It registered a marked advance in providing for revitalizing the air in the boat, so as to "make it again, for a good while, fit for respiration." The inventor died without disclosing his method of air cleansing; it was supposed he had some recipe for releasing oxygen from water. Evidently the boat was of some account, as King James I of England safely ventured on a trip in it. Navigated by a dozen oars, it made journeys lasting several hours, below the surface.

Holland did not delve very deeply into submarine bibliography, which was at best a little hazy in information to a parched mind, but the van Drebbel device, such as it was, was one of the few that caught his attention. He looked nearer to his own day for the guidance he needed, and events far off—in the United

States—finally directed his mind and gave it the needed momentum. He found a mentor in the naval operations of the Civil War.

That conflict had opened a new era in sea warfare. It sealed the fate of wooden ships as combatants. It evolved the ironclad, and in the Confederate "Davids"—a name given to submerged craft which attacked the Union fleet—furnished a forerunner to the modern submarine which Holland was to perfect. Because of its directional influence on Holland's mind, the fight between the *Merrimac* and the *Monitor* will bear allusion in connection with his gropings as an inventor. This battle, the first between two ironclads, though they were not the first of their kind, was epochal, and showed that two iron-wrought vessels could pound each other without vital hurt with the gun power of those days. It showed that the future warship was the ironclad, which was to develop into the heavily armored super-dreadnaught of our own day with its enormous gun power. It forecast the supremacy of impregnable fighting leviathans before whom lesser foes must yield or be sunk unless some new destructive device could be invented to cripple their power.

Probably it was not so much the fight of the ironclads by itself that impressed Holland's mind, as the exploits of the *Merrimac* before clashing with the *Monitor*. The *Merrimac* was a former Union frigate of 3,200 tons, and had been sunk. She was raised by the Confederates and reconstructed of iron, with an armament of two 7-inch rifles, two 6-inch rifles, and six 9-inch smooth-bores. Meanwhile the Union navy authorities rushed the construction of the *Monitor* (the first of a new class of ironclad naval vessels known by that name) in order to complete her before the Confederates could bring the *Merrimac* into action. The *Monitor* had a displacement of 1,255 tons. The contract called for "an ironclad, shot-proof steam-battery of iron and wood combined," which meant a hull of iron with wooden deck beams and side projection. A leading feature was the adoption by its designer, John Ericsson, of the revolving gun turret devised by the American inventor Timby. Her armament embraced two 11-inch shell guns, each 15,668 pounds.

The Union fleet was off Newport News and Fort Monroe at noon on March 8, 1862, when the *Merrimac,* accompanied by a couple of gunboats, crept out of the Elizabeth River into Hampton Roads. She bore down directly on the *Congress* (fifty guns) and the *Cumberland* (twenty-four guns). A heavy broadside from the *Congress* made no impression on the *Merrimac,* but the latter's return fire of shells crashed through the wooden ship's sides with deadly effect. The *Merrimac* came within 300 yards of the *Congress* while receiving the fire of the heaviest guns of the *Cumberland.* The double assault hardly touched her. She drove her iron prow into the *Cumberland,* raked her with shell fire, and left her sinking. The *Congress* had run ashore. After receiving more of the *Merrimac's* destructive shells, she caught fire and surrendered. The *Cumberland* sank with her flag flying. Another Union vessel, the *Minnesota* engaged the *Merrimac's* attention, but had grounded where the latter vessel could not approach within a mile, and the attack was abandoned.

The *Merrimac,* with her escorts, returned to Norfolk. She caused the Union side a loss of two vessels and 250 men. The Confederate loss was nominal. Several shore batteries had attempted to aid, but their shots at the *Merrimac* were as ineffective as those of the Union guns.

The next morning the *Monitor* came and stood alongside the stranded *Minnesota.* The

Merrimac coming up, the battle followed. The result was counted a victory for the *Monitor,* which had rushed to the scene from her shipyard without a previous trial trip. At any rate, she saved the *Minnesota* from the fate of the *Congress* and *Cumberland,* and inflicted more damage on the *Merrimac* than she herself sustained. The *Merrimac* quitted a five-hour battle leaking, with damaged armor, twisted stern, the muzzles of two guns shot away, and a riddled funnel and steampipe.

It will be seen which of the two engagements was likely to have made the greater impression on Holland. The clash between the *Merrimac* and *Monitor* differed only in degree from an encounter between modern battleships. The supremacy of the ironclad—which set Holland thinking—was determined by the *Merrimac's* earlier exploits. Bearing down on the Union navy, she wrought terrible destruction and escaped scathless from the Union guns. Her achievement sounded the knell of wooden navies and told Holland that a new power had arisen in sea warfare, a destructive and defensive force which bade fair to become unassailable to existing engines of attack.

Holland was teaching in the North Monastery schools at the time. Ruefully he read the accounts of these sea battles in the *Cork Examiner*. He did not welcome the coming of the ironclad. It turned his eyes to England. Her navy, already supreme, he foresaw with an augmented strength by the transition of her doughty fleet from squadrons of sturdy oak into terrifying and irresistible monsters of iron hulls. It foretold a continuation of British naval power.

Holland's early life had been passed amid the miseries of the devastating famine that caused the great migration of those days from Ireland to the United States, for which British rule rather than nature was held responsible. He had imbibed a deep hostility to England; it was a determining factor in turning his thoughts to submarines. Britannia's rule of the waves meant her continued rule of Ireland. Challenge the power of her fleet by devising a new weapon of destruction, and the way for Irish freedom was open. An earlier Irish American, Robert Fulton, a forerunner of Holland, who invented a submarine in Nelson's day, was told by Lord St. Vincent, one of England's great sea lords, that his device would be mainly useful to the weaker naval power; it promised to be of little value to the nation which commanded the seas.

Armor protection for warships had engaged the attention of Europe before the Civil War. The French sent two "floating batteries" against the Russian fortifications in the Crimean War, and a set of English "floating batteries" were burned on the stocks by Russian spies. British naval opinion at this time was averse to armored vessels; neither the *Merrimac's* exploits nor the *Monitor's* fight with her had persuaded England's war lords that wooden fleets had had their day.

But Holland knew that the example of other nations, in this case the United States, would force England to adopt ironclads, and that, once accepting new-fangled ideas, she would be more enterprising in putting them into practice than any other country. Holland decided that his work lay beyond such ships and against them. He constituted himself a Jack-the-Giant-killer, drafting plans in his Cork schoolhouse aiming at the inception of a lilliputian craft that would sink a mighty dreadnaught—a British craft for preference.

His anti-British attitude turned his thoughts from submitting his schemes to the British admiralty or shipbuilders. How he felt about it in those days he thus confided in a reminiscent mood:

"I knew that in a country where coal and iron and mechanical skill were as plenty as they were in England, the development of the large armor-plated ships must come first. Therefore I must get to a place where mechanics in shipbuilding were less advanced, and the available material for big armor-clad vessels scarcer. Then, too, I was an Irishman. I had never taken part in political agitation, but my sympathies were with my own country, and I had no mind to do anything that would make John Bull any stronger and more domineering than we had already found him."

Incidentally, the time was to come when the Holland submarine, conceived as a weapon against England, became an auxiliary arm of that country as a protection to her Grand Fleet.

CHAPTER III

The Confederate "Davids" as forerunners of the Holland boats.—Effect on inventor's mind of the *Huxley's* achievement in sinking the *Housatonic*.—Bauer's submarine (German), Bushnell's *Turtle* and Fulton's *Nautilus* as further object lessons.—Submarining as a discouraging pursuit.—Hostile public sentiment. — Practical undersea navigation science scoffed at as a dream.

AGAIN the naval innovations produced by the Civil War invited Holland's attention. He speedily realized that there were many things to be studied, if only in order to avoid them. The Union government had been beguiled into constructing an iron undersea boat, thirty-five feet in length and six feet in diameter, to destroy the *Merrimac*. The Confederates themselves sank the *Merrimac* after her bout with the *Monitor*. Perhaps they foresaw her ultimate destruction by a submerged foe. She would probably have been equal to any attack by the iron boat named; at any rate, no use was made of the contrivance. It was equipped with apparatus for producing oxygen, and the air was to be purified by forcing it through a vessel containing lime. The method of attack called for a diver in submarine armor who was to leave the boat and attach a torpedo, exploded by clockwork, to the enemy craft. The inventor was a Frenchman who decamped after receiving his rewards.

The Confederates were more enterprising. They built several semi-submarines about which little has been written. These craft, known as "Davids," were so called as a tribute to David Bushnell, one of Holland's forerunners, and also because they sent an enemy to "Davy Jones's Locker." They were designed to destroy the largest ships of the Union fleet.

The first boat was built of boiler iron, cylindrical in the center, with conical ends, and had a length of 54 feet, a beam of 5.6 feet, and a height of 5.6 feet in the center.

It was provided with an ordinary boiler which generated steam for a marine engine coupled direct to a shaft connected to the propeller.

For offensive purposes water ballast was taken into tanks and the boat submerged awash. In this condition of trim only some ten feet in length of superstructure could be seen. She then looked like a mass of timber with a projecting funnel. The funnel, being telescopic, could be lowered several feet to make the boat as invisible as practicable. A torpedo was carried on the end of a long spar.

It consisted of a copper case with semispherical ends, measured 10 inches in diameter and 32 inches in length, and contained 134 pounds of gunpowder provided with chemical fuses, which exploded the charge on coming in contact with an enemy ship. The automatic torpedo had not then been developed.

These steam "Davids" were not constructed to dive, but took in water ballast for running on the surface awash. The first boat was successfully launched and manned by a volunteer crew. In one of the first trials a passing steamer caused a heavy swell to break over the boat when the hatch was open. This swirled down the opening and swamped the boat. The commanding officer was the only one of the crew saved. Notwithstanding this mishap, the boat was raised and a second volunteer crew, under Lieutenant Glassell, after a few trial trips, essayed a night attack on October 5, 1863, against the Federal ships off Charleston. He fell in with the *Ironsides,* a ship much dreaded on account of her heavy attacks on the forts. In common with other ships, the *Ironsides* had been specially warned to look out for submarine attacks, and after dark shifted her anchorage every night.

The officer of the watch on this occasion saw approaching what seemed like a plank with a cylindrical pole attached to it. The quartermaster was thereupon ordered to hail the object. The reply was a volley of musketry from the open hatch of the submarine, killing a Federal officer. The object came closer. Shortly afterward there was a heavy explosion, which shook the vessel, threw a column of water on the spar deck, broke a man's leg, flooded the engine room, and started many leaks, with some external damage above the water line. The explosion was effected by a spar torpedo, but it was set too near the surface, and the damage done, therefore, was not so great as it might have been had the charge been more submersed. Moreover, it swamped the submarine. The lieutenant and two others saved themselves by swimming clear of the boat and were rescued by a coaling schooner.

Early in 1864, Admiral Dahlgren, commanding the Northern squadron, was warned by spies that an improved submarine had been launched, of a slightly different type from that which attacked the *Ironsides*. He ordered extra lookout precautions to be taken, but few of his officers believed the submarine would be able to reach the outer anchorage of Charleston harbor. The Southerners were aware of this confident view, and determined at all hazards to reach the ships and blow up as many as they could.

Their new weapon was known as the *Huxley*, and became of note as the only submersible they possessed which produced effective results. Hunley It was a cigar-shaped craft of boiler iron and measured 35 feet in length, 3 feet in beam, and 5 feet in depth. It had a small conning tower, very low. The vessel was propelled by hand power, not steam, as were the early boats. A crew of eight men worked on a sort of pump handle for turning the propeller, and another man steered. The air supply was sufficient to last the crew two to three hours. A form of hydroplane was fitted externally at the foremast end to assist in keeping the boat low in the water and for making small dives.

Hunley

Like her sisters, the *Huxley* was at the mercy of the swell caused by passing steamers, and underwent some tragic sinkings before effecting her crowning achievement. The accidents occurred only when the vessel was on the surface; while operating submerged, it was safe. Once, as it lay awash, with hatches open, the swell sank it, with eight of its crew, only its commander escaping. It was raised, a new crew volunteered, and capsized again, with the hatches open, this time losing six of the crew. Again the boat was raised, the crew remanned, and an experimental trip made to the sea bed. There it remained, for reasons unknown, with its new crew of nine dead within it. The Confederacy was not lacking in brave and devoted men. Once more the boat was brought to the surface, and a fourth crew volunteered, eager to risk their lives in another descent.

On the night of February 17th they succeeded in getting the boat over the bar, and directed her on the surface toward the nearest vessel anchored off Charleston. This turned out to be the new wooden U. S. frigate *Housatonic*. The officer of the watch and lookouts saw, a few hundred yards off, what they thought was a small boat making toward them. On nearing the ship the strange craft was hailed, but no answer came. The crew were at once sent to quarters; but it was then ascertained that the pivot guns could not be depressed sufficiently to hit the object if they had been fired. The order was next given to slip the warship's cable. The stranger came nearer and touched the side. As the propellers of the big ship moved, a loud explosion followed the grazing and cracking sound of the breaking spar which carried the torpedo from the bow of the submarine. Admiral Porter thus described what happened:

"At about 8.45 P. M. the officer of the deck discovered something in the water, about a hundred yards away, moving toward the ship. It had the appearance of a plank moving along the water. It came directly toward the ship and, within two minutes of the time it was first sighted, was alongside. The chains were slipped, the engines backed, and all hands called to quarters. But it was too late; the torpedo struck the *Housatonic* just forward of the mainmast on the starboard side in line with the magazine. When the explosion took place the ship trembled all over, as if by the shock of an earthquake, and then sank stern foremost, heeling to port as she went down."

Many of the crew were saved by the boats of a ship anchored near by, but an ensign and several men were drowned.

For a time it was supposed that the *Huxley* had escaped. But nothing more was seen of her. Some years later, when divers were sent down to examine the wreck of the *Housatonic,* they found the gallant vessel lying alongside the big ship, with the bodies of her fourth crew of nine men on board. It was supposed that the *Huxley* had been drawn by suction into the hole her torpedo made in the *Housatonic* and held there by the water pressure.

Thus the fourth crew went the way of the others, but with the sinking of a fighting ship to their credit. Of the thirty-six men who formed the four crews, thirty-two were drowned.

The *Huxley's* exploit was the first instance of a submarine destroying an enemy, and the last until the Great War of 1914. Here loomed an interval exceeding half a century. Brooding over his inchoate plans amid his scholastic environment in Cork, Holland could not readily conceive—if he ever permitted the fantastic dream seriously to possess him—that his would be the mind that would direct the submarine to the development it reached in the twentieth century. That was to be his destiny, though fifty years was a long way to look forward to its realization. The foolhardy daring of the *Huxley* had registered an important notch in the vicissitudes of early under-sea navigation; it proved that the submarine, even in its then primitive stage, was worthy of respect. "The fish of steel with the brains of a man" was in the borning.

The Conderates were not the first to use a submarine in time of war. The credit for this distinction belongs to a Bavarian soldier, Wilhelm Bauer, a wood turner by trade, who, a decade earlier, devised a craft for Germany in the shape of a dolphin, which succeeded in breaking up the blockade of the Danish fleet off Kiel. Later the vessel was sunk, due to the collapse of her hull from excessive water pressure, the crew escaping. Bauer had trying experiences with his device that may be classed with Holland's. Germany discouraged his invention and he turned to England, then to America, then to Russia, his own country branding him as unpatriotic, while herself discarding him. In 1855 his plan was accepted by Russia, for whom he built a boat, wherein, seventeen feet under water, he wrote letters to King Maximilian of Bavaria and the Grand Duke Constantine, and remained beneath the waves throughout the ceremonies attending the coronation of Alexander II in that year. In 1887 dredging operations in Kiel harbor caused the raising of the boat, which is now on exhibition in the Museum of Oceanography in Berlin.

Even in the early days of Holland the world had nothing to learn regarding man's ability to live and work under water. The Revolutionary War had produced a boat which could be submerged and made to rise to the surface, navigable either below or on the water. This was the invention of an undergraduate of Yale College, David Bushnell. It was utilized in 1776 against the British fleet, and embodied the fundamentals of most of the elements essential in successful submarine work. The boat, shaped like a turtle, and called the *Turtle,* floated in the water with the tail down. It was only large enough to hold one man. It had tanks and pumps, anchor operated from inside the boat, screw propeller at the bow, another at the top with its axis vertical, rudder and torpedo in the stern, and at the top of the boat a screw operated from within, intended to be worked into the planking of a ship at anchor. The torpedo was fastened to the screw by a line, and when the submarine moved away the torpedo remained with the screw. The torpedo was a block of oak containing a charge of about 150 pounds of gunpowder, and contained clockwork mechanism to enable the operator to escape before it exploded.

An attempt was made one night in June, 1776, to sink the British ship *Eagle,* sixty-four guns, anchored off Governors Island. The operator failed to attach the torpedo to the under-planking of the vessel, the screw having struck an iron bar, and the tide swept him away. Unable to reach the *Eagle* again, he detached the torpedo and left it floating on the water. Presently the British were startled by a terrific explosion, which left them unharmed but nervous. It would seem that had the *Turtle* been anchored under the *Eagle,* the operator would have been able to find a purchase for the torpedo screw in copper sheathing or wood, and thus have achieved his purpose. Certainly, the torpedo acquitted itself admirably, but was denied a close enough location to the vessel. Strong tides, the small speed of the boats, and the difficulty of seeing clearly when submerged caused the failure of the two other attempts to attach torpedoes to British vessels.

The time was not ripe for submarines. Public opinion did not favor them, nor did governments, then and later, even in Holland's time.

Some twenty years after Bushnell's experiments with the *Turtle,* Robert Fulton devised his submarine already mentioned, embodying the same features, but on a larger scale, and met with the same discouragement. Like Holland, he was of humble origin. He first acquired note in Europe as a painter, and later, in his native land, as a pioneer of the steamship. But as a submarine inventor he could not go far beyond paving the way—for Holland among others.

Fulton's boat was in the form of an ovoid, very elongated, and nearly six feet in diameter. He improved on Bushnell by adding reservoirs containing compressed air, which enabled him to remain under water longer than any of his predecessors had succeeded in doing. A reservoir, into which water was introduced, caused the boat to dive at will, and a force pump, to drive out the water, caused her to rise. Sailing on the surface, he was able to furl sail, strike mast, and disappear within two minutes. In England he blew up an old hulk provided for the purpose, and destroyed a small schooner in Brest harbor. An experimental boat he built for France, called the *Nautilus,* was put through its paces on the Seine in 1801, but Napoleon declined to continue the experiments because of the low speed attainable (about two knots) when submerged.

The French Minister of Marine even refused Fulton the protection as a belligerent in the wars in which France was involved, on the ground that submarine warfare was piratical.

"This type of warfare," he said, "carries with it the objection that those who undertake it and those against whom it is made will all be lost."

This proved to be true enough in the Civil War, but it was too early a prophecy to apply to the World War. It undoubtedly expressed the popular and official sentiment of the time, with the result that England and the United States, as well as France, rejected Fulton's boat, and he discontinued further experiments. He turned his attention with more profit to the navigation of ships by steam.

Holland thus had ample discouraging precedents to divert him from pursuing his hobby. Up to his leaving Ireland for America in the early 'seventies of the last century, the submarine was still regarded as an uncanny and brutal thing, when it was not scoffed at as a pipe dream. But the chief objection to it was its insecurity. Every man who went below the waves in such a contrivance gambled with death. The truth, of course, was that the way to successful undersea navigation had not yet been discovered. The underlying principles remained, as they had done for centuries, half-baked in the minds of inventors. They had yet to develop and coalesce their ideas into a practical science. Holland, however, had reached firm ground. Bushnell, Fulton, and the others provided it, but they did no more. He started to build where they left off.

CHAPTER IV

Holland's task to raise the submarine from the plane of immaturity.—What an efficient submarine must not do.—His early design for harbor defense.—The torpedo problem.—Preserving a boat's specific gravity and controlling her descent.—Water ballast.—Adjusting a boat's operation to the changing specific gravity of water, salt and fresh.—Jules Verne's *Nautilus* as a fictional forerunner of the developed Holland type.

HOLLAND'S first submarine plans were drafted in 1859, when he was a youth of seventeen. One sketch showed a boat with a gunpowder engine for motive power. Later he discarded it as worthless. This matter of locomotion—an engine suitable for a submarine—early arose among other problems. He was of opinion that previous experiments with submarines had failed chiefly because the need of proper motor power had not been realized. An undersea boat inadequately powered was as useful as a water-logged ship; poor motor power made a poor submarine.

In 1870, while taking a vacation, he gave renewed study to this and other physical difficuties. He was daunted by the task he set himself, devising a practical trustworthy submersible seemed so insuperable. But he decided that the idea was at least worthy of cold investigation before finally rejecting it as unworkable.

He had a long road to traverse beyond that followed by Bushnell and Fulton. He set out to raise the submarine above the plane of immaturity. It should not be the victim of its own depredations nor be sunk by the swell of passing vessels through poor seamanship, like the *Huxley;* not have to depend on a torpedo attached to a screw or at the end of a long spar to effect its purpose. Going under water need not be a hazardous undertaking; remaining on the sea bed could be safe. Strong tides need not be a deterrent to navigation. There must be propulsion by other means than man power. Storage of energy and, equally important, storage of air, must be provided for, and clear vision when submerged, both within and without the boat. There must also be proper ballast and buoyancy and the consequent retention of specific gravity; and torpedoes must be self-propelled without disturbing the vessel's balance.

At the outset of these renewed studies came the initial difficulty of carrying sufficient air to support the life of those within a submerged boat. The first question a layman asked about submarine navigation was, how long could a crew live on the amount of air ordinarily carried? Long afterward, several practical experiments were undertaken to demonstrate this. The first was made with the Holland submarine *Fulton,* and clearly proved that a crew of men could remain in a submarine submerged for several weeks on the amount of air actually carried in the boat at the time of submergence. Holland early succeeded in convincing himself that this fundamental element of air presented no obstacle that could not be overcome.

The next question was, how to prevent the boat from sinking to the bottom when under water and how to handle her when submerged, in case sufficient power were available. He readily found the solution to this problem. It was plain that if the boat and its contents together were of the same weight as an equal volume of water, a very slight force would make the boat move in any direction, either up, down, or horizontal, and, therefore, it could be propelled by the ordinary propeller and its motions in the vertical plane controlled by ordinary rudders. There seemed to be no other vital difficulties in the way. The question of the strength of shell to resist pressure of the water was, apparently, simple.

One of the tests we had to make with every submarine built later for the United States government was to sink the boat to a depth of 200 feet and remain at that point fifteen minutes before coming to the surface. The pressure per square inch on the hull at this depth is about 93 pounds. In this test we had to demonstrate that the boat was sufficiently strong to withstand the pressure without undue strains or leaks.

Holland completed a design that embodied most of the principles developed later in the perfected boats. It embraced the building of a craft for harbor defense only, large enough to carry one or two torpedoes and two or three men. After the plan was completed, he laid it carefully aside among other papers and thought little more about the subject.

The plan embraced the germ of a torpedo boat that would combine the maximum of protection for both boat and crew, with accurate steering, and the greatest allowable speed, destructiveness, and steadiness. Thus equipped, a boat should be able to attack at a distance of one to two thousand yards, and be brought near enough to an enemy to fire a submerged torpedo with a minimum of risk and injury.

Discharging torpedoes, however, would involve a disturbance of a boat's balance without safeguards. The weight of a discharged torpedo must therefore be replaced. Otherwise an alteration in trim would be caused by the change of position of each torpedo in the interior of the vessel while loading it into the expulsion tube and in making ready to fire it. It was necessary to maintain the total weight and trim of the vessel unaltered by the process of loading, firing, and reloading the expulsion tube.

Hence the preservation of the specific gravity of the boat as a whole, and of its trim, was of high importance. To a constant depth of submersion the boat's specific gravity must be maintained, or at least be capable of nice variation by suitable devices within the control of those on board, and not open to chance variation. It was equally important that a boat's center of gravity should be protected from chance variation, especially fore and aft, where such a disturbance would arbitrarily affect the relative immersion of the bow and stern. The tendency to chance variation in both the specific gravity and the center of gravity was due, in addition to the launching of torpedoes, to fuel consumption and the expenditure of ammunition in firing. Holland's device for safeguarding the boat from such variations—though at this time he was a long way from reaching the stages of development I am outlining—was the automatic admission of water in the spaces occupied by the fuel, torpedo, or other substance consumed in the proportion that would compensate, by weight and position, for the weight lost by the boat.

It was also necessary to control automatically the depth to which the boat descended. Provision must be made to avoid the risk of injury from striking the bed of a waterway and from the hydrostatic pressure encountered at too great depths. The need, simply stated, was for a means of sustaining and increasing the buoyancy of a boat to an extent sufficient to arrest its further descent after it had reached the predetermined depth of submersion. Holland for this purpose was to introduce compressed air reacting on and displacing dispensable water in the usual ballast tanks and of a tension sufficient to exercise a force greater than the hydrostatic pressure.

Further regulation of water ballast was called for to enable a submarine to operate with equal facility in fresh or salt water or in an uncertain mixture of both. Tanks, either wholly or partly filled with water, were to be the means of putting a boat in proper condition for diving. A like need was the provision of a special ballast tank whose water must be so regulated—increased or diminished at will—as to adapt the boat to the degree of salinity of the water in which it was to operate, so that it would dive with facility. This requirement was due, of course, to the difference in specific gravity of salt and fresh water and the variation of this difference from the degree of salinity. The rapidity with which a boat could be put in diving condition depended on regulating automatically its total weight. The weight should increase in proportion to the increased specific gravity of the water as the boat passed from fresh to saline water, and be correspondingly reduced in moving from salt to fresh water. Holland was to devise automatic means of varying the total weight of the vessel in accordance with the specific gravity of the water of flotation. A point of moment was the need to affect the change quickly and in bad weather, without the requirement of great care by the person operating the boat.

The testing of submarines was dictated by the specific weight of the water in which they operated. They were usually tried out in bays, harbors, and estuaries along the coast, where fresh water flows in considerable quantity. The variable specific weight of the water at different points, due to different degrees of salinity, produced material variation in the buoyant power of the water.

In New York harbor, for example, which became Holland's field of operations, the specific weight of the water varied at different points. This variation was found to be due to currents which changed with the stages of the tides and the direction and force of the wind. There was a consequent—and inconvenient—variation in the buoyancy of a submarine boat. With changing conditions of tide and winds these variations in specific weight were manifested at the same point in a bay or harbor at different times.

Consider what would happen if a submarine boat were adjusted for diving with the proper reserve for buoyancy in water which had reached the maximum of salinity, and with ballast tanks filled without adjustment for buoyancy at the minimum salinity of the water. It would sink to the bottom. What would happen under the reverse conditions, where the reserve buoyancy was adjusted for fresh water, or for water of flotation having the minimum salinity? The boat would not dive in water of the maximum salinity or specific weight. If the boat's volume displaced 75 tons in fresh water, 2.1744 tons of its volume would emerge or be exposed above the surface were the boat placed in salt water of ordinary salinity. As the volume of reserve buoyancy was only about seven per cent of this difference, it was apparent that differences in the specific weight of the water must be provided by changing the boat's weight correspondingly.

All these considerations of submarine operations were problems in store for Holland to solve in practice. They are surveyed here from the vantage point provided by the perspective of time, as a sort of uncharted sea that he was to penetrate, and in which he had to find his own bearings by means of the compass located in his resourceful mind.

It is something more than a coincidence that the year in which Holland came to the United States (1872) was marked by the publication of Jules Verne's *Twenty Thousand Leagues Under the Sea.* So Holland had fiction as a basis for his studies, as well as fact. The point was of moment. Jules Verne founded his submarine of fiction upon the submarine of fact, and then departed from fact in order to make his *Nautilus* (named after Fulton's boat) achieve wonders beyond the field of the possibilities of the time. Holland had not yet "arrived" to show how faithfully Jules Verne's fiction was foreshadowing fact. How closely the modern submarine realized the imaginary craft of Jules Verne was thus remarked by C. H. Bedell in 1917 in addressing the American Society of Mechanical Engineers on Holland's achievements:

"As far as the handling of a submarine is concerned, whether under way, on the surface or submerged, or at rest on the surface, poised at any depth or resting on the bottom, the boats of the present day are as perfect as the *Nautilus* of Jules Verne. We may even, if we so desire, make our boat so that when it is at rest submerged, a man with a diving helmet, and entirely disconnected from the submarine or the surface, may pass from it into the sea and explore the ocean floor for an hour or more, as Captain Nemo of the *Nautilus* did. That such construction is not used is due to the fact that there seems to be no material need for such operations."

Captain Nemo and his crew performed several feats beyond the range of Holland or any other inventor. They drove the vessel by electricity, not obtained from storage batteries, but from the sea itself by a method unexplained, and with propulsion from such a source managed to travel round the globe on one supply of energy. A real submarine of to-day has to ascend periodically to recharge its storage batteries. Perhaps the future has in store a self-sustaining submarine producing its own energy as it proceeds. Captain Nemo also sent his *Nautilus* down to depths of 6,000 feet and more, which involved a water pressure exceeding 5,000 tons, a weight no boat as described by Verne could have borne, especially with its large glass windows. The author, among other things, gave unusual vision to Captain Nemo and his men by making them see objects under the sea half or three-quarters of a mile away by the light of the sun or by strong electric lamps. Real eyes cannot penetrate the sea through anything like such a distance, even with the aid of powerful illuminants. Barring these departures from reality, Jules Verne was showing Holland what could be done.

CHAPTER V

Holland in America as an immigrant.—Renews his submarine studies in Boston.—Project shelved.—Marking time as a teacher in Paterson, New Jersey.—Approaches United States government with his invention.—Official discouragement.—Irish financial aid enables him to build a boat.—Trial in Passaic River helped by power from an improvised steam launch with a beer barrel for boiler.—Inventor stays under water twenty-four hours.—Device derided.—Friends gratified by test and assist him to build a better boat.—Abandons teaching for submarine building.

HOLLAND had reached the age of thirty before he left Ireland for the United States. His salary of thirty pounds a year (then about $150) did not yield much surplus, even for the frugal bachelor that he was. The accumulation of a sum sufficient to cover a steerage passage to an American port meant waiting on time, but waiting on time was one of the first things an inventor had to learn.

He had been teaching for fourteen years, or since he was sixteen, a period long enough to shape a man permanently to the trade he followed and render him unadaptable to another pursuit. His equipment for his future field as a submarine pioneer was wholly theoretical. By actual experience he knew nothing of determining the gravity of a floatable object under water, of the niceties of ballast and its relation to water weight, of the manifold variations in the specific gravity of fresh and salt water or a blend of both. There is ample water round Cork, but no Holland submarine ever entered it. His submarine was under his hat. Not Cork harbor, but the Passaic River was to enlighten him beyond the sound theoretical knowledge he had patiently acquired as a background in Ireland.

In November, 1872, he found himself an immigrant in Boston, taking up his quarters with his mother and two brothers, who were living there at the time. A young man of slender build, under medium height, Irish from top to toe, with a rich brogue that flavored the clear enunciation he had acquired from his calling, and with twinkling, humorous eyes peering through spectacles, he looked about wonderingly at his new surroundings, but not as a field for exploiting a submarine yet unborn. He was rather concerned about seeking a livelihood as a teacher.

His dream, however, had received a new impetus in his changed environment. It took him one winter day to the Boston Public Library in search of literature on the subject of submarines. He found none. This was not surprising. Submarine literature did not begin until twenty years or more later, when Holland himself in large part was to create it. In returning from the Library he slipped on an icy pavement and broke a leg—a mishap which laid him up for three months. It occasioned an enforced inactivity which inevitably beguiled his mind to a renewed study of his hobby. His submarine plan lay in an old envelope, and the envelope was buried at the bottom of his trunk. He decided to let it stay there.

"Wait," he thought. "Let me do it again, and see what will be the difference between the submarine I would build to-day and the one I thought out long ago."

In his convalescence he drew another set of plans and compared the result with his original scheme, the details of which he had forgotten. The two he found identical in almost every element. He had thus evolved the same plan twice, with a wide interval of time between, and he reasoned therefrom that he must be on the right track. It was a naïve conclusion, but not a wrong one. He had to depend upon his own thinking processes—for he was delving into a field of nautical science which up to his day had proven so barren that little or nothing had been written about it to guide him. Nevertheless, the second plan had to go the way of the first—it was laid aside.

The year 1873 brought him to Paterson, New Jersey, where he resumed teaching at a parochial school. There he marked time for two years, laying up mental and financial ammunition for continuing his submarine work. His pay was better than he had received in Cork, but his savings did not go very far toward meeting the outlay needed for building an experimental boat.

His thoughts turned to the United States government as a possible sponsor, and in 1875 private funds were promised him for developing his invention if he could win over the government to indorse his plans. The outcome was the careful preparation of a free-hand drawing of a boat with a cigar-shaped shell fifteen feet long, in which was room for one man sitting upright, who was to be the steersman and crew, his legs furnishing the motive power by means of a treadle, which worked a screw propeller. An indirect opening to the Navy Department was provided by Holland's contact with a young friend or relative of George M. Robeson, who was Secretary of the Navy at the time under President Grant.

This naval student had failed in his first examination for the navy, and Holland coached him for his next essay, enabling him to pass his second examination. Holland availed himself of this link with high officialdom and submitted his plan to Secretary Robeson, who referred it to Captain, later Admiral, Edward Simpson, then stationed at the newly established War College at Newport, Rhode Island.

Captain Simpson carefully studied Holland's plans, but, while admitting the eventual practicality of everything claimed for the boat, he did not believe any man in his senses could be persuaded to operate it, and that if a lunatic was found who would go down in the vessel, there would be no way of directing it under water. It would be like a man trying to navigate a vessel in a fog.

"And this," Holland declared, "in face of the fact that the Confederate 'Davids' had drowned crew after crew, but had never wanted for volunteers, and also that I was prepared to show that a compass would work as well under water as on the surface."

Besides, vessels had been navigated safely in fogs for a great many years.

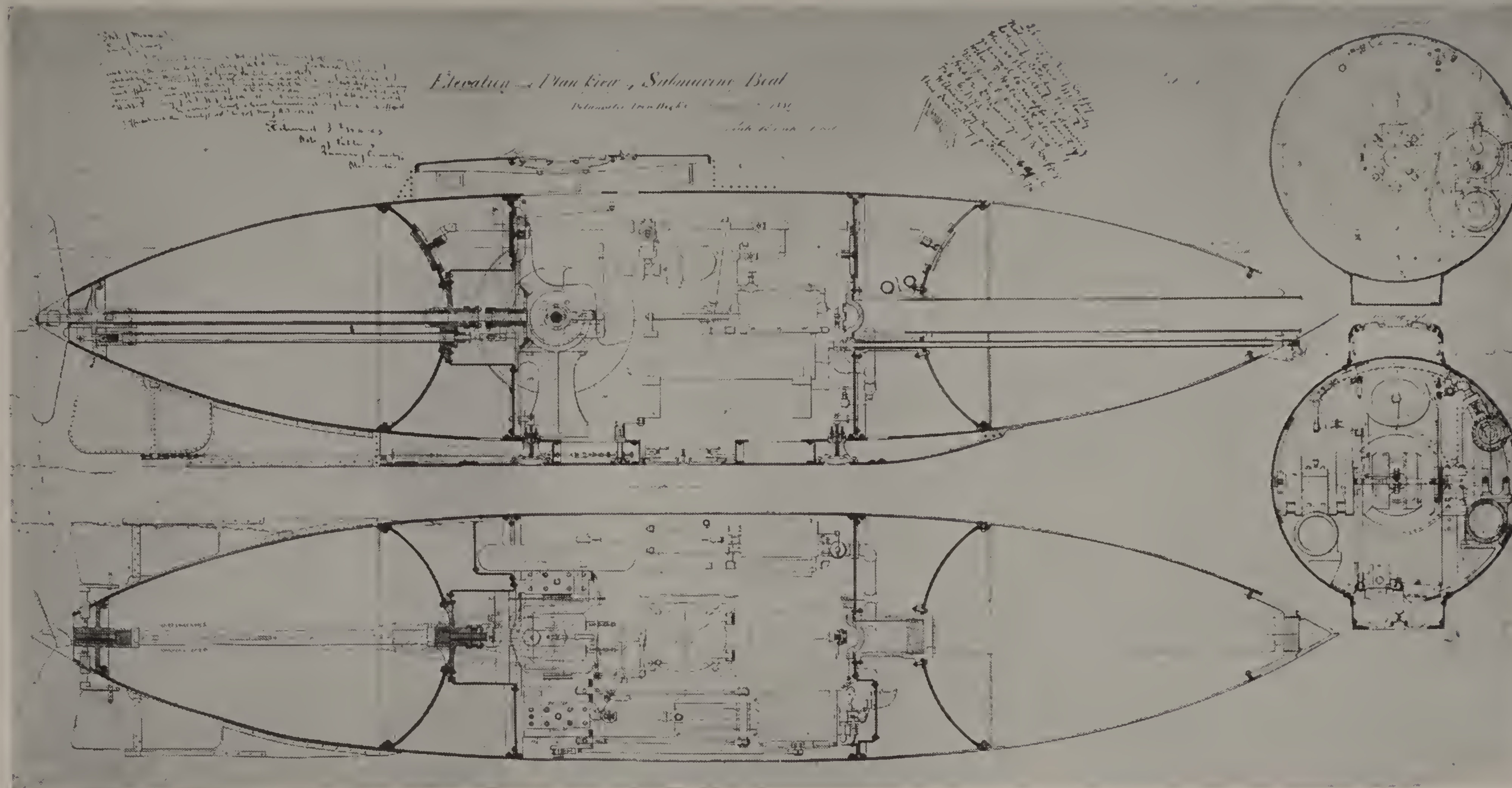
Later Holland wrote Captain Simpson requesting his advice unofficially as to what he should do. In reply the captain again admitted that the plans seemed all right, but advised Holland to drop the whole matter, assuring him that putting anything through the Navy Department was uphill work. "Anything" was very broad and even covered perfection itself. Holland judged that it was wise to follow the advice and put the matter aside for the time being.

Two years later a group of Irish associates had sufficient faith in his project to advance him funds to build a boat on the lines rejected by Captain Simpson. Its construction was conditioned upon their engineers approving the design. Holland prepared a model about thirty inches long, propelled by a coiled spring animated by clockwork. A New York metal spinner wound a hull round the clockwork. The model was tried out at Coney Island and acted as Holland forecast both under water and on the surface. His backers were satisfied and sanctioned the building of a boat to hold one man.

There seemed some warrant for proceeding with the project. Captain Simpson had discarded Holland's design largely owing to the inadequacy of its motive power. What looked like meeting Holland's great need—a motor adaptable to a submarine—appeared on the scene. It was a petroleum engine patented by George Brayton in 1874. Holland examined it and thought it would meet requirements. The engine proved to be a false alarm, but such as the opportunity was, Holland availed himself of it. The oil engine was the only motive power available at the time; the day of the storage battery had yet to come.

A pair of engines was built to fit the boat at a Brooklyn machine shop. The hull was a product of the old Albany Street ironworks in New York City. The completed craft, which was shipped to the inventor at Paterson for trial, followed the general principles of Bushnell's *Turtle*. It was too primitive to be revolutionary. In fact, a similar under-water bicycle, as it was termed, was tested at Odessa about this time. Holland's object in building it was to find a working basis for producing a better craft.

The boat was ten feet long and sloped to a point at both ends. It really consisted of two air tanks held a few feet apart by angle irons lined with sheet iron. The space between the outside shell and the lining formed the ballast tank; between the air tanks and inside the lining were the engines, air pump, gauges, etc.,



PLAN OF SUBMARINE BOAT DESIGNED BY JOHN P. HOLLAND AND BUILT AT DELAMATER IRON WORKS, 1880. THIS PLAN IS IN HOLLAND'S OWN HANDWRITING

and room for the operator, who was so confined in the narrow space that no man bigger than Holland could enter and occupy the boat with the turret closed.

The boat was launched on the placid Passaic River, a little distance above the falls. It was a great day for Holland in this memorable summer of 1877, and an anxious one. If the result was not wholly glorious, at least a decided landmark in his experiences had been reached.

The launching could not be easily accomplished. Holland worked amid the clatter and roar of Paterson's silk factories and machine shops, with their multitude of operators. His submarine experiment had caught their eager interest; every time the inventor appeared in the vicinity where his craft lay he was surrounded by a mob of mill hands. He was seized with stage fright each time and retired precipitately.

The little craft was finally towed well up the river, and the inventor went down in her. He then discovered that the motor apparatus installed was not operated by oil. It turned out to be an ordinary pair of slide-valve steam engines. Their constructor had run them by compressed air and misled Holland into the belief that oil was used. Holland had no intimate knowledge of engine work, but on discovering that he had steam engines in the submarine, he set out to utilize them by what means were available. A little boat was at hand, converted by its owner into a steam launch, a beer barrel serving as the boiler. With the consent of the launch's owner, Holland ran a line of hose from the barrel boiler to the engine of the submarine, the launch trailing behind as he steamed on the surface or dived.

In this manner he conducted his first submarine experiment. Both the runs on the surface and the dives were short because the submarine engines required more steam than the launch used; there was also loss of power through condensation in the line of hose, especially when the boat dived. However, Holland had proved that the boat was practicable or would be with a suitable engine. His copartners sat in the launch and watched the pressure disappear in the steam gauge, which obviated any argument as to why the runs and dives were short. In all he remained under water an hour, but this was not sufficient to satisfy his backers, who, before incurring any more expense, wanted to know how long a man could remain under water. Holland promised them he could stay at the bottom of the Passaic for twenty-four hours.

Testing the air supply was soon determined. There was a pair of mooring rings on the submarine placed well toward either end. One Friday evening toward six o'clock a rope was made fast to each mooring ring. Holland boarded the submarine and, after fastening the turret, sank her to the bed of the river. In two boats on the surface were four men, two in each, holding the end of the ropes hitched to the mooring rings. These men were witnesses that Holland went down and stayed; he could neither move the boat nor emerge without their knowledge.

He remained at the bottom until 6 P. M. the following day, when he blew out the water ballast and came to the surface.

Altogether, the boat behaved as well as it could under the circumstances. Summing up its achievements, it stuck in the mud when launched; it continually leaked; its engine balked repeatedly—and no wonder. But Holland remained in it under water for twenty-four hours. He always insisted that it embodied the essential principles of his more developed submarines, and that, despite its mechanical and structural defects, it had sufficiently proved the soundness of his underlying conception.

The press and public of the day viewed it as a joke. It was certainly of no value for further experiments; a larger boat was needed. Holland had the craft stripped of everything that could profitably be removed, and abandoned the hull on the river bank. It sank in four feet of mud and there it lies to-day.

His friends were so gratified with the outcome, barring the engine failure, that they readily assented to his building a bigger boat. This more ambitious project was not undertaken until 1879. Holland by this time began to feel on firm ground—the ground was none too firm—as a designer of submersibles, especially in view of renewed financial support. The outlook led him to give up his ferule at the Paterson school and to devote his whole time to his second venture.

CHAPTER VI

The mysterious *Fenian Ram.*—The engine problem. —Projectile tests and their oddities.—Strange voyages under New York harbor.—Suspicions of designs against British craft, due to Fenian unrest in Ireland. —The Fenian Skirmishing Fund the source of Holland's financial backing.—Irish-American factors in the development of the submarine.—Fenian aims and hopes. —Real significance of the *Fenian Ram.*—The modern submarine an outgrowth of the Irish question.—The boat and a companion model stolen.—End of Fenian support of Holland.

THE result was the *Fenian Ram,* on which hangs more than a tale. The boat took two years to build, at a cost of $13,000. Its construction, though not secret, was shrouded in mystery. It evoked the most fascinating of speculations. It was designed for use in war; but no war was in sight except the chronic strife between England and Ireland. Its progress toward completion, for all who cared to look on, was to be observed at the East River shipyard of the old and noted firm of Delamater at the foot of Thirteenth Street. Many foreigners, some of them naval officers, watched the craft take shape. Two Turks, who held high posts under the Sultan, were so attracted by the enterprise that they besought Holland to design a submarine for their government, but the inventor had not yet reached the stage of supplying war craft to other countries.

Its length was 30 feet; at its widest the diameter extended to 6 feet, and inside, between the air tanks, was space for three operators, engine room and a pilot house. The boat displaced 17 tons gross. Its size was determined on for various reasons, one of which was (the reporters discovered this with a wise wink) that the boat could be contained in a railroad box car of the period and carried to any point perfectly concealed. It had vertical and horizontal rudders, and had an air gun or bow tube which could be discharged under water. It was probably the first submarine torpedo boat, if the term torpedo be given its widest significance.

Holland's partners tardily realized the need of an adequate engine, the outlay for which they had demurred to in the building of the discarded boat. They became eager to utilize the petroleum engine invented by Brayton, to be built by the inventor himself, but required that it be properly tested before the boat was constructed.

At this time the future of the oil engine could not be foretold, for which perhaps Brayton's peculiar device was in part responsible. Almost every detail, according to Holland's brother Michael, was ill considered and complicated, and the working parts defectively proportioned; but a newcomer could only discover these by a costly experience. Holland, having little acquaintance with oil engines, had to depend solely on Brayton in determining the size of the engine for the new boat. From what he could learn he got Brayton to build a ten-inch cylinder double-acting engine; that is, there were two explosions to the revolution. This size did not give Holland the speed he needed, but it served his purpose. The engine proved to be a better product than Brayton had so far turned out, thanks to Holland's suggestions. It was rated at 17 horse-power. The great stimulus which the application of the multi-cylinder principle was to give the oil engine had not come in 1881, and did not for some time after.

During the construction of the boat Holland encountered skepticism and ridicule everywhere, especially at the source,—namely, in Delamater's machine shops. Delamater himself inquired of the inventor where the boat's probable water line would be. The information caused him to shake his head, indicating his belief that the boat when launched would promptly sink. Every employe in the firm looked for the same result.

The boat left the shipyard in the presence of an assemblage of doubting Thomases, most of them the artisans and mechanicians who had helped to build her. She was hitched to a steam tug and towed across the river to the Gut, just north of the New Jersey Central Railroad's ferry, where was a sheet of water little used in those days. A wharf was at hand for tying up, as well as engine and machine shops in case of need. Here the boat lay for several months, receiving finishing touches. Holland hired a mooring at Bay Ridge, below Owl's Head, where the boat, in the summer of 1881, was eventually put through her paces in favorable surroundings that enabled him to come to the surface at any time without risk to others or himself.

During the tests on the New Jersey side, Captain Ericsson, designer of the *Monitor*, offered Holland the use of several projectiles with which to try out the air gun. The boat was submerged a few feet, and the first shot fired. The projectile traveled thirty feet from the bow, rose to about forty feet, then came down and buried itself in the mud. The second projectile traveled about the same distance, cleared the water, went over a breakwater bounding the basin, and struck some piling on the end of a pier, behind which a man sat fishing. The man was on the right side of the pile. Torpedoes don't behave like that now. Later a different type of projectile was fired, and carried out its mission of remaining under water.

The boat's performances were counted a success—that is, it registered a marked advance on the showing of its predecessor. The Brayton oil engine helped in part to make the boat a practicable submersible, though the motor never at any time acquitted itself too well. But it justified Holland's favorable opinion of it. The air supply proved to be as deficient. The two reservoirs, guaranteed by the builders to hold respectively 450 and 500 pounds to the square inch, did not contain a pressure of more than 400 pounds in each, and that only for a short period. The tank's dimensions enabled him to run under water for not more than two hours at full speed, and then the air gauge would show symptoms of decline. If Holland pumped up pressure at night he could not expect to have enough left to make a trip in the morning. Holland, however, was well content with the stage reached. He could operate the boat at a speed exceeding seven miles an hour on the surface, running awash, and at a rate little less when diving, which the boat accomplished with dexterous swiftness.

The inventor and his undersea shell contributed to the gayety of the people on ship and shore round and about New York. The newspapers devoted columns daily to his uncanny voyages below the waves. What was he after? He was not maneuvering a toy, but a torpedo boat. But no British warship was in sight, even in the far offing. There were numerous mercantile vessels flying the Union Jack within reach, but the newspapers contained no account of a mysterious torpedo, fired below the surface, sending one of them to the bottom of the sea. People were not prepared for such maritime phenomena whisking about under the surface and suddenly bobbing up like some visitant from the nether world. Frequently the boat would startle the occupants of an excursion boat or a tug by emerging like Neptune out of the watery deep. Was it a sea serpent, a whale, or a sunk derelict strangely endowed with life? The opening of the conning tower and the appearance of Holland's good-natured and beaming Irish face was reassuring.

Holland moved about undersea without lights. He believed that the darkest water in the world lay below New York harbor, though I have found the water denser in San Francisco Bay. Twenty feet under the surface at New York it was so muddy that the effect suggested the darkness of midnight. Above that depth, however, he had clear enough vision, the daylight penetrating that far down. On the surface or awash his vessel was not exempt from being sunk by passing vessels. Such sinkings were small matters. The Confederate "Davids" thought nothing of them, nor did Holland. He or his assistant would swim clear, and the boat was later raised uninjured.

It went the uneven tenor of its way, like an undersea policeman assigned to some strange surveillance beyond the comprehension of the folks on *terra firma*. Public curiosity regarding the boat was insatiable. But no inkling of its purpose or the objects of its owners could be obtained. The newspaper men were balked in their quest for information. Their failure to induce Holland or his sponsors to let them examine the boat doubtless explained the derision with which the boat was always referred to in the press. A New York *Sun* reporter finally did some reasoning of his own after Holland refused to permit him to go down in her. His conclusions were none too subtle, as the motive which animated Holland from the first in his pursuit of a practicable submarine was no secret. As the machine was evidently designed for the destruction of warships, the designer, unmistakably Irish, judging by his brogue, and as the Fenians just then were causing trouble in Ireland, he decided that the vessel was intended to blow up the English navy. The reporter went further than that. He effected a little coup that made the boat famous. He called it the *Fenian Ram,* and the name clung to her forever after.

Holland was not a Fenian, and avoided participating in political activities. This was not the case with regard to the men behind him who held the purse strings. Their purse was the Fenian Skirmishing Fund. The situation was not without its comedy. If Holland's position can be defined, he was nominally a partner in their project, but actually a subordinate agent whom they employed to build and operate a submarine to their order, and to that end worked for them under a retainer. At best the *Fenian Ram* provided them with an outdoor sport and cheering imaginings. For Holland its use was more fruitful. It was an argosy laden with ideas through which naval tactics were to be revolutionized in the days to come. The Fenians gained nothing by their outlay, but in financing Holland they played an unconscious part in laying the ground for enabling others to achieve an aim that was beyond their power in 1881.

The Fenian movement on this side of the Atlantic had been braced by the revival of disorders in Ireland, which were to culminate in 1882 with the murders in Phœnix Park, Dublin, of the British Cabinet's Secretary for Ireland, Lord Frederick Cavendish, and his chief aid, Mr. Burke. The repercussion that reached New York created new hopes in Irish-American breasts of rendering effective assistance to their compatriots at home. No prospect was in sight of critical Anglo-American discussions developing into hostilities against England that would draw the United States into aiding Ireland to obtain her freedom. The Fenians reasoned that the Irish question would become a vital element in such an Anglo-American war. As they saw the outlook whenever war clouds lowered over the two countries, war would be the signal for a revolution in Ireland, and an American army, reinforced by zealous Hibernians, would invade Canada. The war, they predicted, would inevitably end in an American triumph, and Irish freedom would be a condition of peace.

But the chief parties to be considered were overlooked. The American and British governments knew better. Almost a decade previous to 1881, a sore issue upon which the Fenians relied to bring war—the *Alabama* claims, arising from Confederate raids on Union shipping by a British-built privateer—had been settled. Popular irritation against England over the *Alabama* was intense enough and the Fenians did their part in fomenting it.

The question is merely academic at this day whether the government would have let country-wide resentment lead them into a conflict with England over the *Alabama* in the chaotic days of Reconstruction following the Civil War, to say nothing of whether the English people would sanction such a war rather than meet the American demands for the *Alabama's* depredations. In 1872 England willingly met these claims, as decided against her by the Geneva arbitrators, to the amount of $15,000,000.

The point of interest, as a more or less remote background to the building of the *Fenian*

Ram in 1881, was that the Civil War had attracted thousands of Irish-Americans, not so much to get into a fight against the Confederates, but to qualify themselves as fighting men in a hoped-for conflict with the British. O'Donovan Rossa, in his reminiscences wrote of visiting, in 1863, a Fenian armory and drill room in New York. The men he saw there seemed to be soldiers or learning as recruits. Many of them, he remarked, had volunteered to go into the battlefields of America so that they might be able to fight the battles of Ireland against England. "I saw this spirit in most of the speeches I heard," he commented. After the Civil War these men formed a formidable nucleus for an Irish army; thousands had returned to Ireland as trained warriors, tested on Southern battlefields, and organized secret recruiting.

After the Civil War, these men, with their fighting mettle on edge, were looking for trouble. The war was a factor in producing the Fenian brotherhood, and but for that conflict the movement might never have obtained the headway it did in America. Certainly the movement of itself would not have produced such a trained fighting contingent.

The Fenians fed upon American dissatisfaction with official England's attitude, which leaned to the Confederates, and it was the Union side, therefore, to which the Fenians flocked to gain army experience. Yet it was the Union government, after the war, that stemmed a movement whose growth it had indirectly influenced. The demobilized Irish-Americans, assisted by Civil War veterans, attempted to invade Canada, only to be thwarted by American forces, not Canadian. Their organization actually decayed, not so much by reason of its own lack of coherence, as by restraints exercised from Washington. Its members were contravening American law in plotting against a country with which the United States was at peace.

The month of May, 1870, witnessed a final raid into Canada, when again United States forces interposed and stopped it. After that the movement languished; internal strife among the Fenians further contributed to its decline. Many of the Irish in America had never sanctioned it, nor did the Catholic Church.

In 1871 there appeared some prospect of its revival. A number of its most notable champions, hitherto immured in British prisons, among them O'Donovan Rossa, were released, and immediately emigrated, most of them, to the United States. Their arrival aroused the Fenian brotherhood to a semblance of its old enthusiasm. They gathered the scattered forces and exchanged fervid addresses with their American compatriots, re-echoing Irish aspirations and inherited hate of England. The refugees would join none of the Fenian factions. They rather sought to reunite the brotherhood under their own leadership, but in this they did not succeed.

This was the Fenian situation when Holland came to the United States in 1872, and it had not materially changed in 1881. The *Fenian Ram's* appearance on the scene imparted a piquant flavor from the public viewpoint, to the movement, but it could not be said that the boat revived it.

The real significance of the *Fenian Ram* was more far reaching than any achievement the Fenians could hope to accomplish with it as part of their program. An overlooked factor in the genesis of modern submarine navigation lay in the circumstances under which this odd little craft came into being. Holland and his Irish associates builded better than they knew. Their primary object contemplated the founding of an Irish submarine navy to harass British shipping plying between English ports and Canada. Its Utopian impracticality, in view of the lack of the efficient modern engine, periscope, and self-acting torpedo, can be passed over. What the Fenians actually achieved, all unwittingly, was to aid in bringing to the plane of practical seamanship an engine of war fated in the then dim future to effect by other hands the purpose they had at heart by wrecking a havoc upon British naval and mercantile shipping beyond their wildest flights of fancy.

The source of the strength behind Germany's challenge to Great Britain's supremacy of the seas in the World War could thus be traced to Fenian sponsorship of Holland's early experiments. In brief, the Fenians fathered the modern submarine in its infancy.

"Behold!" the surviving Irish compatriots of 1881 could say in 1914, "We started this thing. Without our funds John P. Holland could not have gone ahead."

Whatever other inventors in the same field might have devised had not Holland been forehanded in mastering the science of modern navigation, it belongs to the record to say that the Irish question produced the modern submarine.

The *Fenian Ram,* and a companion boat, a small affair sixteen feet long built on the same lines, came to an inglorious end. This nucleus of a Fenian navy was stolen under cover of darkness. The *Fenian Ram* was hitched to a mooring at Bayonne; the smaller boat lay in the stocks, incomplete, without a gasket at its turret and without an engine, being designed for propulsion by the occupant using hands and feet to operate the propeller. There had been dissensions among the Fenians, and a faction decided that the development of their scheme would better proceed if the boats were taken from Holland's hands. A night come toward the close of 1882 when a tug bore down on the mooring place and obtained possession from the watchman of both boats by a forged order. The boats, lashed to the tug, both floating on the water, were towed out into the darkness. The tug headed for Long Island Sound, where the smaller boat broke from her lashings and sank in 110 feet of water. Attempts to recover her by dragging failed. The *Fenian Ram* was taken to the suburbs of New Haven, Connecticut. There the kidnappers discovered that they had a white elephant on their hands; none of them knew how to manage her. She was hauled ashore and a shed built for her near a brass factory.

"I'll let her rot on their hands," Holland decided, on learning of the theft.

The engine was removed and utilized in the factory. The hull, I believe, still lies in its old shed, covered with dust and kindling wood. But the *Fenian Ram,* if it did not serve its owners' purpose, more than justified its existence.

The stealing of the boats ended Holland's experiments for several years. No more support could be looked for from the dissolved group of patriots. He took up other employment and spent his leisure in planning another boat.

CHAPTER VII

Naval attitude to Holland's device.—The Zalinski boat and its fate.—Setback for inventor.—Government competitions for submarine bids initiated by Secretary Whitney.— Submarine progress at home and abroad. —French enterprise.—Secretary Herbert shudders at dangers of submarines.—Test of effect of gun-cotton explosions on water-tight tank containing a cat, rooster, rabbit and dove, to show submarines are safe from their own projectiles.—Further competition for submarine construction follows.—Simon Lake's *Argonaut* type.—Holland secures contract to build the first American naval submarine.—The ill-starred *Plunger*. —Inventor's conflict with red tape and gold lace.— Congressional committee hears naval experts on submarine outlook.—A step forward.

The Navy Department had looked on distantly at the diversions of the *Fenian Ram* in New York waters. Officially it gave the boat no cognizance; an inventor was merely prospecting in an unexplored and hazardous field. But among the navy personnel, as well as the army, Holland's experiments made a lasting impression. A nucleus of unofficial naval support in his invention developed and buttressed his wavering faith. His adherents included Captain (later Admiral) George H. Converse, one of the foremost ordnance experts in the navy, and Lieutenant-Commander (later Admiral) W. W. Kimball, who commanded the torpedo-boat flotilla in the Spanish-American War. But it was from the army, in the person of Lieutenant Edward Zalinski of the Fifth U. S. Artillery, a notable inventor of military devices, whence Holland was to receive the next impetus to proceed.

The outcome was what became known as the Zalinski boat. This was a working model of the utility of the inventor's ideas. Zalinski the future *Holland*, which determined finally became drawn to Holland's device by a like enthusiasm for delving into uncharted seas in search of the attainable. At the time he was devoted to the development of his pneumatic dynamite torpedo gun which threw a heavy charge of high explosives some 5,000 yards by compressed air. Torpedo guns came very materially into Holland's field. There was thus a common line of approach in the minds of the two men. Zalinski also bent his inventive aptitude in devising an intrenching tool, a ramrod bayonet, a telescopic sight for artillery, and a system of range and position finding for seacoast and artillery fixing.

Zalinski, in 1886, organized a company for Holland, who thereupon built an experimental boat on wooden sheathing held on an iron frame, propelled by petroleum, and equipped with an automatic apparatus, employed for the first time, in steering a straight course. Her length exceeded 50 feet; her diameter was 8 feet. For air reservoirs she had steel tubes about 14 inches in diameter and 20 feet long, eight on each side. Holland's submarines were thus growing in length and equipment, as well as in other respects. The chief object in building her, like the requirement of his first sponsors, was to satisfy the stockholders that it was possible to navigate a vessel under water. The *Fenian Ram's* ability to operate successfully 37 feet under sea counted for nothing.

As an offensive weapon the Zalinski boat was equipped with novel devices, though they are now familiar enough. It had a pneumatic gun for firing large dynamite charges. It was designed to approach readily within a mile of an enemy, with only its small conning tower awash, afterward sinking below the surface and able to observe what was transpiring above the water through a camera tube, which served as a periscope. Within striking distance it was planned for the bow, from which the gun muzzle protruded, to be brought above the surface and a shell sent through the air. The boat would then submerge, both by the recoil and the action of the engines, to take up another position for renewing its attacks. More than that, it had apparatus to enable it to pass underneath an enemy ship and automatically attach a torpedo to her bottom, to explode when the boat was at a safe distance. In this latter device the stage reached was not beyond the methods of Bushnell and the Confederate "Davids," but in other respects it embodied a range of possibilities which future submarines were to realize. In those days it was viewed as a floating gun carriage.

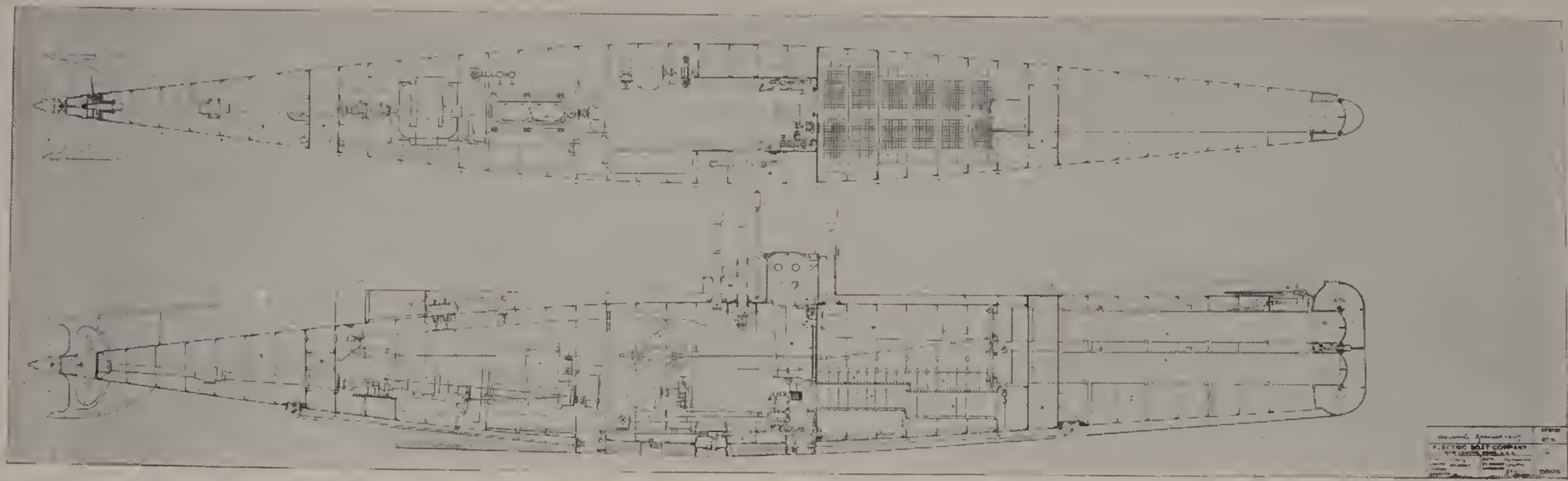
Naval interest was more than ever attracted by the Zalinski enterprise, but the boat proved a misadventure from the start. There were difficulties of construction, due to Zalinski's overzeal. The boat was built on what used to be the parade ground of old Fort Lafayette. From the dock there she was launched down the runway by a naval officer whose assistance Zalinski thought he needed, but who knew little about the matter. The boat struck a spile in the runway, gradually filled, and sank. She was raised and turned keel up to get the water out of her tubes and other equipment, but she was injured beyond repair. Her speed on the surface never exceeded four miles an hour, and her engine—a second-hand Brayton device—was too small. Zalinski vainly spent much of his own means to make the boat perform according to specifications.

Thereafter little was heard of Holland publicly for several years. The Zalinski enterprise added to the discouraging vicissitudes he had already undergone, and he despaired of making any real progress. The following year, however, the group of naval men who believed in submarine navigation induced Admiral Sicord, then chief of the Ordnance Bureau, to prevail upon President Cleveland's Secretary of the Navy to obtain an appropriation for constructing a submarine boat for the government. The Secretary was William C. Whitney, who accomplished much in developing plans for improving the naval service. The American navy of later days owed much of the world-wide importance it attained to his progressive policy. He was attracted to the submersible as a potential naval arm, obtained an appropriation of $150,000 and in 1888 invited all comers to submit bids.

The competition drew attention to the progress of other submarine inventors, native and foreign. Among the competitors, besides Holland, were Professor Josiah Tuck, an American inventor, and T. V. Nordenfeldt of

Sweden. The Tuck device, known as the *Peacemaker,* dated from 1885 and had survived several short trips on the Hudson River. It was propelled by an ordinary steam engine. Caustic soda was introduced into the boiler to generate steam. Its mode of attack was by means of a torpedo fastened to the bottom or side of an enemy ship by magnets, or held there by buoys rising under the keel. A water lock was provided through which a man, clad in a diving suit, could pass to lay the mine. Jules Verne applied this principle of egress under water to his fanciful *Nautilus.* The length of time the *Peacemaker* could run, either on the surface or submerged, was limited, and it never advanced beyond the experimental stage.

Nordenfeldt's submarine of this period, devised in association with G. W. Garrett, an English inventor, was of more account. Improved boats of the type were built for Turkey, Greece, and Russia. An ordinary steam engine operated it; when submerged, the steam was obtained from hot-water tanks, in which it was stored at a pressure of 150 pounds. The boat of early design was built of steel, had a length of 64 feet, a diameter of 9 feet and a displacement of 60 tons. Later, the type de-



DESIGN OF THE SMALLEST SUBMARINE EVER PUT IN ACTUAL SERVICE. DISPLACEMENT, 35 TONS. THREE OF THESE BOATS WERE BUILT FOR THE RUSSIAN GOVERNMENT AND ACTUALLY PUT IN SERVICE AND SUCCEEDED IN TORPEDOING ENEMY SHIPS

veloped into large vessels with an extensive radius. Vertical screws on each side, placed amidships, were used by a separate engine to submerge the boat. A constant horizontal position was maintained by means of horizontal balanced rudders connected with a weighted pendulum hanging in a tank of oil and water. The boat of the 'eighties was calculated to withstand a pressure of only 50 feet; hence it was certain to collapse at a depth of 100 feet. Twelve hours were necessary to store up sufficient pressure in the hot-water reservoirs to prepare the boat for a trip under water; arranging for submerging took from twenty minutes to half an hour. The speed attained on the surface was six knots; submerged, only two or three knots were made. A surface run of 150 miles was effected without recoaling, but under water the longest run did not exceed 500 yards. The boat contained no air-cleansing equipment nor carried compressed air for breathing purposes. A cradle was provided on the outside to carry movable torpedoes. When submerged the boat was visible from the mast of a gunboat throughout its course, but this fact was attributed to its light color and nearness to the surface.

France had entered the submarine field with the *Gymnote,* invented by Gustave Zédé. It was submerged by water-tight compartments filled till its buoyancy was greatly reduced, and then made to dive by means of horizontal rudders. It attained a speed of ten knots, and was the forerunner of a much more ambitious craft, of the same general design, the *Gustave Zédé.*

Another French pioneer, Goubet, was also active about this period, with government support. The French, in fact, were more receptive to the possibilities of submarine navigation than any other nation. The Goubet type were small and light, the original pattern weighing under one and one-half tons, and were driven by electric motors, the power stored in accumulators, or propelled by hand at the rate of about five knots. The torpedo was attachable to a ship's bottom by means of a rubber disk, serving as a "sucker." Russia in 1881 was credited with having ordered no less than three hundred boats of the Goubet type, but if delivered they vanished from the Russian navy before the twentieth century began; at least, nothing was ever heard of them. Later Goubet developed his devices, one new feature being a propellor which worked on a universal joint, so that it could be changed as to the direction of thrust. Two he constructed for Brazil weighed ten tons and had an arrangement of prisms and lenses for sighting projected from the surface.

Spain had the *Peral,* an ambitious contrivance over 70 feet long and displacing 87 tons, electrically driven. It sank hulks with great success, but failed to realize expectations, and later lay at Cadiz, a rusty mass of iron.

The American offer of bids enlightened the navy regarding the stage submarine navigation had reached both in the United States and abroad, but, owing to an informality in the bids, all were thrown out. The following year (1889) another competition resulted in Holland's design being chosen. But the year marked the close of the first Cleveland administration. The new Secretary of the Navy, General Tracy, who displaced Secretary Whitney, did not take any further action, and the submarine appropriation was diverted to other uses.

Holland became more than ever discouraged by the shelving of his plans through the change of administration. But for the persuasion of Lieutenant Kimball, he would have abandoned the submarine field.

Congress discovered the subject in Cleveland's second administration (1893-97). Submarine invention was moving abroad and the question could no longer be disregarded. The American navy was pitiably weak; relations were also strained between the United States and Great Britain over the Venezuelan boundary dispute. The Naval Committees of both houses examined the question exhaustively and determined to appropriate $200,000 for experimental submarine construction.

Cleveland's Secretary of the Navy, Hilary Abner Herbert, had shuddered at the idea of submarines before he could be prevailed upon to act on the appropriation. He held that they would be death traps for anyone who went down in them. Apparently mindful only of what befell the *Huxley* in the Civil War, he feared that they would be hoist with their own petard, in that a torpedo from one would destroy the assailant as well as the assailed.

He was finally induced to sanction an experiment—the first test of under water craft under the auspices of the American navy. It was a crude affair. The question to be determined was whether any floatable submerged vessel and those in it would be in danger of destruction from the recoil of an explosion, say from a torpedo it discharged at an enemy.

SUBMARINE "PLUNGER" ALONGSIDE DOCK. BALTIMORE, 1895

A small craft—nothing more than a water-tight tank—was put under water, containing a quartet of very bewildered passengers—namely, a cat, a rooster, a rabbit, and a dove. At a considerable distance from it a charge of guncotton was exploded. The experiment was repeated several times, the tank being moved nearer to the guncotton with each explosion. At the final demonstration the tank was less than one hundred feet from the guncotton. Then the craft was brought ashore and found to be undamaged. The rabbit and the dove were dead, but the cat and the rooster appeared none the worse for their confinement. The cat fled, highly incensed, with distended tail; the rooster flew out and crowed. Mr. Herbert was thereupon assured that submarines need not be their own destroyers.

The result was another contest for bids in 1895. It attracted eight designs, among them, in addition to those of Holland, Tuck, and Nordenfeldt, one by Simon Lake and one by George C. Baker, an American inventor who had successfully launched a submarine device for experimental purposes on Lake Michigan.

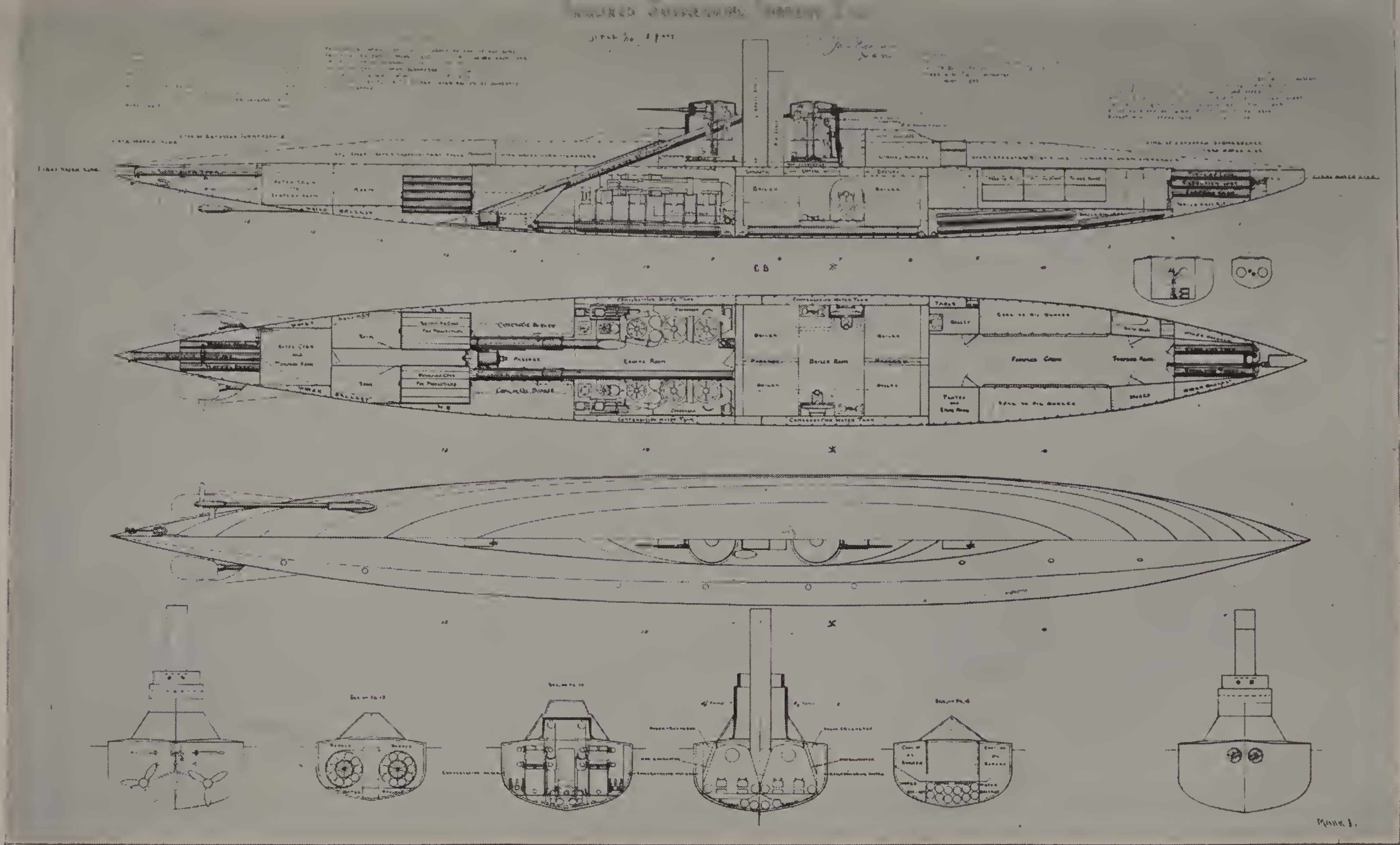
About this time Simon Lake had entered the field with his *Argonaut* type, an undersea craft designed for peaceful purposes which the government had under consideration for some years. Lake stressed its great value in laying submarine foundations, recovering sunken treasure from the ocean bed, and from sea-coast and river bottoms, submarine wrecking, and for scientific purposes. It was designed to roll on wheels along the sea bed like a locomotive. The vessel was operated by steam on the surface, and by an electric motor under water. Lake departed from this type and built war submarines.

Holland obtained the award for building the first American navy submarine at the price of $150,000. This was the *Plunger*. A company, the J. P. Holland Submarine Boat Company, had been formed to construct it. Now began a conflict with the official mind which the inventor had to endure for many years. Numerous difficulties confronted him from the start. The Navy Department required that every item be first submitted to its experts for approval. The building of the *Plunger* consequently proceeded at a snail's pace, subjected to manifold changes devised by naval technicians. The outcome was a boat that departed far from the ideas over which Holland had labored. It was "improved" to such an extent that it failed. Holland was ill during much of the time the vessel was on the stocks, and his absence gave the naval technicians their opportunity.

The boat was to be triple screw, propelled by steam and installed with one 300 h. p. and two 600 h. p. engines. One of the trial requirements was that she should run at full speed on the surface with boilers developing 1,500 h. p. The limit of time given from the instant her engine-room telegraph was set at "stop" until her funnel was hauled down, hatches closed, and boat fully submerged, was not to exceed one minute. One could imagine what would happen to a crew of men sealed up in an air-tight case with a boiler that a few seconds before had been developing 1,500 h. p. The naval experts did not insulate their fire boxes, and, as a result, no human being could stay inside with the hatches closed, so intense was the heat.

The boat tardily reached completion in 1897 and had abortive dock trials. She presented the appearance of a gigantic torpedo, extending 85 feet in length, almost 12 feet in diameter, and displaced 168 tons. For armament she had two submerged torpedo tubes and a supply of five Whitehead torpedoes. At full speed awash she was depended on to endure a twelve-hour run, and at slow speed a radius of 1,000 miles. She never got beyond her dock at the Columbian Iron Works, Baltimore, where she was built, except for her final disposal to the little town of New Suffolk, Long Island. There her hull lay until the World War, when she was removed to New London, Connecticut, and used for the training of divers by the navy.

Holland foresaw the failure of the *Plunger* long before it was completed. He proposed to his company that he be permitted to construct another boat based entirely on his own plans and under his own supervision, and he would abide by the result, whether success or failure. The company perceived the need of proceeding with their project according to Holland's ideas, unhampered by captious and ill-digested naval orders, as well as delays incidental to the construction of such a novel craft under government control. Their purpose was to hasten results and to produce a trustworthy model upon which future contracts could be made. This second boat, the famous *Holland,* was built at the company's own expense. The cost, however, was sensibly lessened by a gift of $25,000 made by a wealthy New York woman.



SKETCH OF ARMORED SUBMARINE TORPEDO BOAT DESIGNED BY JOHN P. HOLLAND, 1894. AT THAT TIME SUBMARINES WERE HARDLY THOUGHT OF. NOTE FORESIGHT OF MR. HOLLAND IN DESIGNING THIS BOAT. AT THE TIME THIS PLAN WAS DRAWN HOLLAND'S ASSOCIATES CONSIDERED IT WHOLLY VISIONARY AND IT WAS NOT UNTIL 1917 UNDER PRESSURE OF THE GREAT WAR THAT CONSTRUCTION OF THIS TYPE WAS UNDERTAKEN.

Years later Holland spoke feelingly to an interviewer of his experiences with the official mind.

"Why do you come to me?" he demanded.

"Because you, if anyone," the interviewer answered, "should be an authority on the subject."

The interviewer recorded that Holland smiled grimly. Behind the smile lay bitterness, recollections of his struggles to get his ideas adopted by the Navy Department, his many heart-burnings as one board after another sat upon his plans, and sat upon them in more senses than one. The inventor had realized the dictionary definition of a board—a thing "long, narrow, and wooden."

"So you have sought me as an authority on submarines?" Holland mused. "Go down to Washington, and you will find plenty of people there who will tell you I know nothing about the subject, nothing at all."

This was not strictly correct. Holland had stanch naval supporters, but they could not overcome the bureaucratic inertia and impediments that beset the inventor's path. Several voiced their belief in his work before the Senate Naval Committee, which in 1896 gave renewed attention to the subject without waiting for the completion of the *Plunger*. The Senators held long sessions and heard exhaustive testimony from naval officers.

The view of Captain (later Admiral) A. T. Mahan stood out as a headlight among their opinions.

"In our present unprotected condition," he wrote, "the risk of losing the money by the government by reason of the boat's (Holland type) being a failure is more than counterbalanced by the great protection the boat would be if a substantial success."

The Senate committee wanted to be shown, and was shown. In these days, when the submarine has more than fulfilled all the predictions made for it as a war weapon, the evidence they heard has an ancient savor, but it was needed to prevail on Congress to make further provision for such a naval innovation.

"If I commanded a squadron," said Rear-Admiral Jouett, "that was blockading a port, and the enemy had half a dozen of these Holland submarine boats, I would be compelled to abandon the blockade and put to sea to avoid destruction of my ships from an invisible source, from which I could not defend myself."

"Give me six Holland submarine boats," declared Lieutenant-Commander Kimball, "the officers and crew to be selected by me, and I will pledge my life to stand off the entire British squadron ten miles from Sandy Hook without any aid from our fleet."

"A fleet of such boats should be added to our navy without delay," urged Lieutenant Nixon, the designer of the battleships *Indiana* and *Massachusetts,* "in order that the necessary experience may be had in their handling."

Congress was cautious. As an outcome of the Senate hearings it authorized the Secretary of the Navy to contract for the building of two further Holland boats at a cost of $175,000 each, provided that the *Plunger,* then under construction, fulfilled requirements. But no action was to be taken until the *Plunger* was fully tested and accepted.

Holland, as indicated, had despaired of the *Plunger,* upon the success of which appeared to depend further government support. He had the foresight to perceive that the authorities would recognize the *Holland* as a sounder criterion on which to stake the navy's chances of getting a submarine fleet. Accordingly, the inventor bent his efforts toward making his second boat acquit herself according to specifications. Fortunately, the *Holland* was built away from red tape and gold lace.

CHAPTER VIII

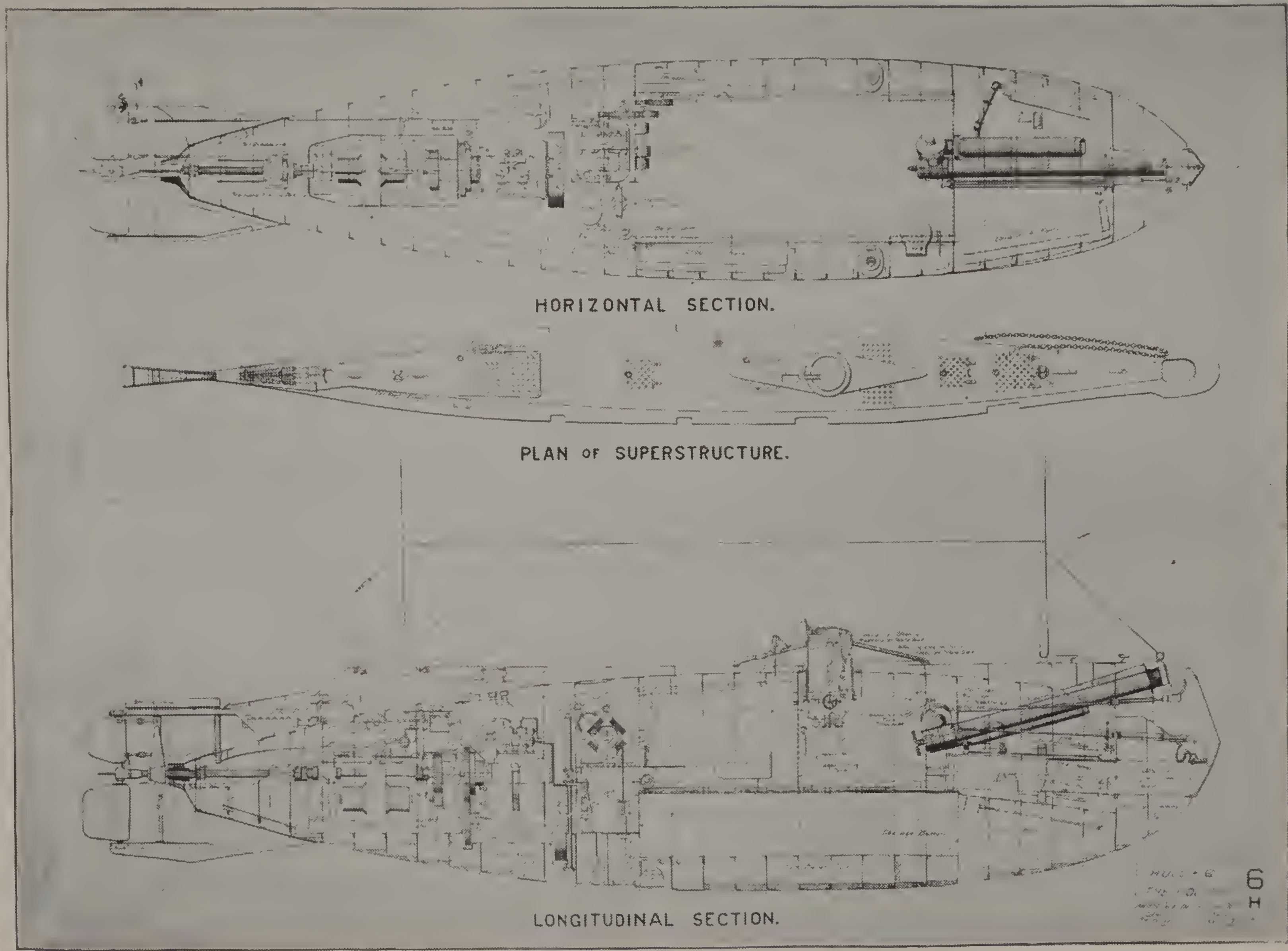
The famous *Holland* and the beginning of my association with its inventor.—The new boat as the parent of most modern submarines.—Her features and capacities.—Beginning of real under-water navigation in America.

My association with Holland dated from this period. I was living in Philadelphia at the time as a technician connected with the Electro-Dynamic Company of that city. My first acquaintance with the *Holland* was made through reading a graphic newspaper account of her remarkable features, as they were then regarded. It reminded me of Jules Verne's *Nautilus;* one seemed as real as the other. I was asked if I would care to take an undersea trip in the *Holland,* and my answer was that not for anything would I be tempted to do so. Yet it fell out that in less than six months I found myself in command of this boat, and for twelve years afterward I spent more time under water than on the surface.

I became the skipper of the *Holland* through being the accidental means of reconditioning her electrical equipment after she had sunk, when near completion, at the Crescent shipyard, Elizabethport, New Jersey, then owned by Lewis Nixon. One night, when the boat was lying alongside dock, undergoing minor changes, a careless workman left a small valve open. In the night the boat filled and sank. She remained submerged for about eighteen hours, during which her electrical equipment and machinery were at the mercy of salt water. At that time motors and generators were not protected from the injurious effect of contact with salt water as they are to-day. The insulation was ruined, and some means had to be found to restore it. To remove the electrical equipment and rebuild the boat meant a large outlay, as the entire upper part of the hull would have to be raised in order to take out the machinery. The Holland Company vainly tried every known method of drying out the motors and generators by applying heat externally. As a last resort the Electro-Dynamic Company was notified, and sent me to investigate. After an examination I decided that there was only one way of remedying the trouble, and if this course was adopted there was a chance of restoring the boat. The Holland Company assumed all responsibility, the work was started, and in four days completed and the job pronounced satisfactory.

The *Holland* was regarded as the most important contribution to naval science so far devised. The submarine problem, which had beset experts for a century, had at last come within the field of practical and successful application. We wonder at the perfection the submersible has reached to-day, but it was the result of the labors of inventors wrestling with the idea long before the time of Bushnell and Fulton. Holland picked up the threads which others had lost or could not grasp. Thus submarine navigation was no longer the ineffective pursuit of cranks who had not mastered its fundamentals.

No longer a fad or a toy, the submarine became, in the shape of the *Holland,* a "monster war fish," a "devil of the deep," a "hell diver," as the vessel came to be called. Strictly speaking, the boat was a torpedo, but a torpedo controlled in all its workings by human agency inside the craft, instead of being automatic in its operations. The ordinary torpedo, by an arrangement of springs to counteract the water pressure, was made to go through the water at any depth. It had to follow a path fixed for it beforehand. When it had run its course it came to the surface or sank, in accordance with a predetermined plan. The men inside the Holland controlled her at will.



SECTIONS SHOWING GENERAL ARRANGEMENT PLAN OF ORIGINAL HOLLAND SUBMARINE

As Lieutenant-Commander Kimball put it before the Society of Naval Architects, thousands of submarine boats were actually in use in all parts of the world in the shape of automobile torpedoes, which were nothing more or less than automobile submersibles. The only difference in principle was that an actual submarine had a controlling brain, while directing automata motivated the torpedo.

The *Holland* was 53 feet long, and at her widest part 10¼ feet in diameter. She had a displacement of 74 tons. Her frames were exact circles of steel set a little more than a foot apart. They diminished gradually in diameter from the center of the boat to the bow and stern. On top of the boat was a flat superstructure to afford a walking platform, and under this were spaces for exhaust pipes and for the external outfit of the boat, such as ropes and a small anchor.

A turret extended upward through the superstructure about eighteen inches. It was only about two feet in diameter and afforded the only means of entrance. It was also the one place from which the boat could be operated. At the stern was an ordinary three-bladed propeller and an ordinary rudder; in addition there were two horizontal rudders—

"diving rudders" they were called—which looked like the feet of a duck spread out behind as it swam along the water.

The boat was propelled on the surface by a gasoline engine, and under water by electricity. Holland encountered the usual difficulty in obtaining the right engine; he almost despaired of finding one. The internal-combustion gasoline engine giving large power with small space and weight had just been developed, and large storage batteries with corresponding electric motors were available. Chance took the inventor to an electrical exhibition at Madison Square Garden, where he noticed the exhibit of an electric-light plant designed for a country home. The generator was driven by a 50 h. p. Otto gasoline engine. "That is what I want for my boat!" he exclaimed. He promptly bought the engine and installed it on the *Holland*. But for the development of the gasoline engine, the submarine might never have passed beyond the experimental stage.

From the bow two-thirds of the way to the stern was a flooring, beneath which were the storage batteries, the tank for the gasoline, and the tanks filled with water to submerge the boat. Holland specially showed his genius in his ballast tanks. In later boats he greatly improved their operation. No submarine could be counted a success which did not follow the lines of tank construction that he later devised. In earlier submarines the tanks were constructed without subdivision, large enough to hold the required maximum of water, and consequently were rarely totally filled. Hence this water flowed freely from one end of the tank to the other as the boat's angle changed. This prevented the boat from preserving a proper trim. Holland realized this defect, and laid down the rule that the main storage tanks should be of such a capacity that when entirely filled the boat would be brought to the awash condition only, and that the final adjusting of the buoyancy of the boat must be made by the use of a small tank with only a small free-water surface if not entirely filled. So the main ballast tanks were entirely empty or completely filled.

There were about a dozen openings in the boat, the chief of them three Kingston valves, by means of which the submerging tanks were filled or emptied. Others admitted water to pressure gauges, which regulated or showed the depth of the vessel under water. There were twelve deadlights in the top and sides of the craft. To remain under water the boat had to be kept in motion unless an anchor was used. There was always a reserve buoyancy which tended to bring it to the surface.

It could be steered to the surface by the diving rudders, or set flying to the top by emptying the storage tanks. If it struck bottom, or became stuck in the mud, it could blow itself loose by means of its compressed air. It could not be sunk unless pierced above the flooring. It had a speed of seven knots on the surface and five knots submerged.

It could go 1,500 miles on the surface without renewing its supply of gasoline, and fully forty knots under water without coming up. There was enough compressed air in the tanks to supply a crew with fresh air for thirty hours, if the air was not used for any other purpose, such as emptying the submerging tanks. It could dive to a depth of twenty feet in eight seconds. It could stay at sea, under an emergency, for a week.

There were no periscopes in those days. The ingenious French, who were to devise this valuable eye for the submarine, had not yet developed it from the sighting contrivance of prisms and lenses which Goubet used about this period. The *Holland* consequently had to be handled by porpoising. This was a simple resort to the movements of the porpoise, which the inventor took as his model for diving. In porpoising the boat ran a short distance submerged and then came to the surface far enough to expose the conning tower, thus getting a chance to look round, and then diving. This bobbing up and disappearing was swiftly effected; the boat would rise to the surface from a depth, say, of thirty feet, focus on an imaginary target, if such was the occasion for the maneuver, fire its torpedo, and be quickly under water again.

With the turret clamped down before submerging, the operator looked through little plate-glass windows, about an inch wide and three inches long, which encircled the turret. These windows were valuable while the boat was running on the surface; they gave a complete view of the surroundings if the water was smooth. But once under water, the windows were useless; it was impossible to see through the water. Steering had to be done by compass—until recently considered an impossible task in a submarine boat. A tiny electric light in the turret showed the operator his direction and revealed the markings on the depth gauges. If the boat passed under an object, such as a ship, a perceptible shadow would be noticed through the deadlights, but that was all. The ability to see fishes swimming about in the water is a pleasant fiction.

The only clear space in the body of the boat was directly in front of the bench on which stood the operator in the turret. It was where the eighteen-inch torpedo tube was loaded.

Along the sides of this open space were six compressed tanks, containing thirty cubic feet of air, at a pressure of 2,000 pounds to the square inch. Near by was a smaller tank, containing three cubic feet of air, at a fifty-pound pressure. A still smaller tank contained two cubic feet of air, at a ten-pound pressure. These smaller tanks supplied the compressed air which, with the smokeless powder, was used in discharging the projectiles from the boat.

The machinery was packed away closely behind the turret. Against the roof on the port side was the little engine which steered the vessel by compressed air. On the starboard side was the diving engine, fastened on the roof with disks that looked as large as dinner plates standing on edge at each end. These disks were diaphragms on which the water pressure exerted an influence, counteracting certain springs which were set to keep the diving rudders at a given pitch, thus insuring an immersion of an exact depth during a run.

At one side was a cubic steel box—the air compressor; and directly in the center of this part of the boat, a long pendulum, as in the ordinary torpedo, swung backward and forward as the boat dived or rose, checking a tendency to go too far down or come up at too sharp an angle. On the floor were the levers which, when raised and moved in certain directions, filled or emptied the submerging tanks.

There were also pumps in the boat, a ventilating apparatus, and a sounding contrivance, by means of which the channel was picked out when running under water. This sounding contrivance consisted of a heavy weight attached to a piano wire passing from a reel out through a stuffing box in the bottom of the boat. There were also valves which released fresh air to the crew when necessary in long runs.

This was the craft whose performances were to attract the eyes of the world and earn for her the credit of being the first submarine boat to achieve real success, to the extent to which practicable under-water navigation was then understood.

CHAPTER IX

The *Holland* as another suspicious craft.—Pending war with Spain makes navy authorities watchful of her movements.—Spanish warship in New York harbor in alleged danger of being torpedoed by a wooden projectile from the *Holland's* gun.—Blind search of the elusive submarine by a navy tug.—Difficulties of navigation in New York harbor.—Navy officially recognizes the *Holland* and submits her to tests.—Dubious of her performance.—Changes in operation.—Crudities of equipment.

Early in 1898 the *Holland,* virtually completed, was moved from her Elizabethport shipyard to Perth Amboy, New Jersey. The journey was merely a change of location to enable her to undergo preliminary dives by way of feeling out her mechanism. But the Navy Department attached a dark significance to her movements. The *Holland* was not a government boat and the department had had no hand in her construction. She was produced, as it were, beyond the pale of official recognition. Despite congressional provision for submarine construction, the department's bureaucratic mind remained coldly skeptical as to the practical outcome of the projected outlay. The luckless *Plunger* had failed because of her enormous steam installation and her lack of stability. Why not the *Holland,* too, if not through these defects, at any rate from others she would be bound to reveal? Outwardly the Navy Department declined to admit that the *Holland* was a war vessel; it would not concede that the boat promised to be of service. Nevertheless, the department's action belied its attitude; it nervously watched the *Holland*.

War with Spain was in immediate prospect. Foretokens of that brief conflict were manifest in a rising hostile sentiment against Spain because of the desperate repressive measures to which she had resorted in the hopeless attempts to subjugate the Cubans. The U. S. S. *Maine* was at Havana, whither she had been sent to safeguard American interests from supposed danger through military riots which broke out in that city. As an offset to the *Maine's* presence off Havana, the Spanish warship *Vizcaya* had been sent to New York, and was now anchored in the harbor.

The Navy Department decided that the *Holland* had designs on the *Vizcaya*. It wired an order to the commandant of the New York Navy Yard, Admiral Bunce, to watch the vessel and, if necessary, seize her. The *Holland* had in her bow an eight-inch dynamite gun. Just before leaving Elizabethport several wooden projectiles were made to fit this gun, which, at a distance, resembled the real thing. These projectiles were on board. Several hours after we had left Elizabethport for Perth Amboy a tug from the navy yard appeared, looking for us. Some workmen in the shipyard informed the tug's captain that we were loaded with dynamite shells and had gone down the river. This information, coming on top of the instructions from Washington, started the tug in hot pursuit.

Meantime we had reached Perth Amboy and had tied up out of sight in a basin behind an old canal boat. The navy's tug passed without a suspicion of our presence. After cruising all day in a blind search for us, the tug returned to the navy yard and reported its failure, also, no doubt, that the *Vizcaya* was unharmed. It was several days before we were located.

Numerous changes in the boat's mechanism were found necessary before we made our first test. The dive took place on St. Patrick's Day (March 17), 1898, and ended in a mud bank near Tottenville, Staten Island. Due to some error in the compass, the navigator lost his bearings and the mud bank stopped his erratic movements. Owing to the slow speed, no

SUBMARINE "HOLLAND" ALONGSIDE DOCK. NOTE OUR FIRST WORKSHOP

damage was done, and the boat returned to her moorings none the worse. But enough had been accomplished to demonstrate the possibilities of boats of this type.

In the early days of submarines the compass was one of our most troublesome instruments. Space in our conning tower was limited and we could not use a compass with a card of more than two inches in diameter. Even such an imperfect guide might have sufficed had it not been necessary to place it within a few inches of the steel hull. Owing to its close proximity to the steel, we were obliged to have it heavily compensated with permanent magnets. Accordingly, we had an instrument which was very sluggish and not at all accurate. The boat might take a sudden sheer and deviate a considerable distance off the course before the compass would register the change.

We took serious risks in cruising under lower New York Bay. Once the skipper of a lumber schooner called on Holland at his New York office. The inventor remembered that in diving the previous day he had almost collided with such a craft, but, seeing his danger, had dropped fifteen or twenty feet to clear her.

"I am the captain of that lumber schooner," his visitor announced. "Your boat dived under my craft as I came up the Narrows and struck her bottom, seriously damaging the copper sheathing, and I've come to collect damages."

"If such a thing were so," retorted Holland, "your copper bottom would have ripped off the top of my conning tower and I would not have been here to talk to you now."

The Navy Department took official cognizance of the *Holland* shortly after she was launched. The officer assigned to inspect her, Lieutenant Sargent, reported that the boat had "fully proved her ability to propel herself, to dive, come up, admit water to her ballast tanks, and to eject it again without difficulty." The *Holland,* he added, appeared to him to be more efficient than he imagined her to be before making the inspection, and promised to be an ultimate success.

Trials followed in Prince's Bay, Staten Island, before a special board appointed by the Secretary of the Navy to determine whether the government should take over the boat. These trials were very different from the stringent tests the Holland boats had to undergo later. They consisted only of a submerged run of two miles, during which we could come to the surface as often as we chose and stay as long as we wanted. In addition we fired a dummy torpedo from our only tube, and a dummy projectile from our dynamite gun.

The trials lasted about two hours. No time was taken by the board; it did not know whether the boat was making four knots or twenty-four. Nor was any time taken for the loading of a torpedo; in fact, no member of the board was in the boat.

During our submerged trial run we came to the surface within a few feet of a fisherman who had evidently never seen a submarine. Just what passed through his mind when he saw this uncanny object come up, evidently from the bottom of the sea, we never knew, but the rapidity with which he hoisted anchor and set sail for home led us to believe that he would tell a remarkable story to his friends ashore. It turned out that he had an eye for business, as we received a bill from him for the breaking of one centerboard. The bill was paid, although the responsibility was not ours.

The report of the board was such that the Navy Department recommended further trials. To prepare for another board's inspection, we spent the entire summer making changes and testing improved devices, with our base at South Brooklyn. All our submerged work was done in New York Bay, between Governor's Island and Fort Hamilton, the worst place we could have selected. When submerged we did not know whether we would come up under a mud scow or an ocean liner. Being before the days of periscopes, we had no means of observation except by bringing the boat to the surface.

In November of 1898 we conducted our second set of official trials. They yielded about the same result as the first. The board appointed this time by the Navy Department was headed by Captain Evans, the famous "Fighting Bob" who commanded the battleship *Iowa*. They required us to fire a Whitehead torpedo. We had never before attempted to load the torpedo tube of the *Holland* with a real charge. A part of the boat's structure interfered with the operation, and it was necessary to remove the obstacle before the torpedo tube could be loaded.

We did all we were asked to do, but it was not enough. The board reported that the boat steered erratically; this they believed was due to the inexperience of the skipper. As I happened to be the skipper and did not want the boat condemned, I accepted the verdict. I promised myself that the next set of trials would be run by a more experienced man, and I would be the man.

Up to this time Holland had built five boats. All but the *Holland* had gone into the discard. In each he had placed the rudders forward of the propeller. I have yet to see a boat with the rudder in this position that can be handled satisfactorily. He had always navigated the boats himself and claimed that their steering qualities were good. My first attempt at navigating the *Holland* was during a run made several weeks before the official trials, and I found that steering her was the most unsatisfactory task I had ever undertaken. The criticism annoyed Holland, but he encountered worse from a group of spectators who had been watching our maneuvers from the deck of a small tug. One of them compared the course of the *Holland* to that of a drunken washerwoman.

On all the earlier runs Holland's method of trimming the boat for submerging, from the viewpoint of later submarine navigators, was exceedingly crude. We were always accompanied by a tug which carried several hundred pounds of pig iron, which was utilized as ballast. The boat was carefully ballasted before leaving the dock, but if Holland found that she was too light, when he got out into the bay, with all the tanks full, he would blow out some of the ballast, come alongside the tug, and take on a fresh supply of pig iron. If, on the other hand, he found her too heavy, with tanks all full, he would remove some of the iron. This process would sometimes consume two hours.

At length I suggested to Holland that he adjust this trim by putting in or leaving out water in the forward ballast tank, and put enough fixed ballast on board so that this tank would only be partially filled at any time. This method did not appeal to him, as he did not believe at that time—he did so later—in carrying tanks only partially filled, or they should at least be nearly full.

It took considerable argument to convince him that the change was practical, but a trial was made and the result proved fully satisfactory. It eliminated the necessity of carrying ballast on the tender. Later two trimming tanks were installed to adjust changes of trim due to variation in the specific gravity of the water or in the weight and number of persons carried from time to time.

So far, Holland himself always handled both steering and diving rudders. As we had never operated in water of excessive depth, the usual method followed was to put the diving rudder hard down until the boat was running along the bottom, and then leave it there. If the bottom was level, the boat would maintain an even depth; she could not go any deeper, and the down rudder would keep her from coming up. I suggested that I handle the diving rudder, while he steered. This change worked well and henceforth the diving rudder had a separate operator.

Our instruments were more or less crude. We had no regular gauges to tell us how deep we were submerged, nor accurate clinometers recording the boat's angle when diving, both positions most important to ascertain. In handling the diving rudder I had to depend on an ordinary steam gauge six inches in diameter, calibrated to one hundred pounds. This instrument would register only a small fraction of an inch for each foot in depth, and it was impossible to ascertain from it the actual depth we were submerged by several feet. For a clinometer I used the wooden stool I sat on in handling the diving rudder, and by the "feel" of this stool under me I could tell when the boat changed its angle. Even by this crude arrangement I was able to gauge the boat's angle quite accurately.

The need of a highly sensitive instrument for this work led me in 1900 to invent and patent a clinometer, which I believe was adopted in almost every submarine in the world.

Running a vessel under water varies greatly from operating on the surface. Above water a man, walking from amidships to the bow, will depress the bow, displacing a greater amount of water, and consequently the bow will be able to sustain the increased weight. Once submerged, no change of displacement can occur, and therefore such shifting of weight would cause the boat to take a greater angle. "A boat submerged," as C. H. Bedell explained it in discussing the later Holland boats, "may be likened to a pendulum having a length equal to the distance between the center of buoyancy of the boat and its center of gravity, generally a distance of about sixteen inches, and the weight of the pendulum being the weight of the boat, say 500 tons. A weight moved from amidships to one end of the boat would produce a leverage to swing this pendulum from the vertical—in other words, to cause the boat to take an angle by the bow or stern. As a submarine when emerged will go the way she is pointed, it will readily be seen that change of angle will cause her to change her depth. The man at the diving wheel nowadays not only has his wheel and depth gauge before him, but also a clinometer, a sort of level by which he can tell the exact angle of the ship, and therefore tell whether the boat will change her depth or not as she goes along. As a matter of fact, the boat is swinging up or down most of the time, and it is the duty of the man at the diving wheel to check these motions and control the boat so that she will remain at the depth desired."

In operating the *Holland* great care had to be exercised to obviate a shifting of weight when the boat was running submerged. Nowadays, with much larger boats, a man's weight bears such a small ratio to the total weight that a crew's ordinary movements are readily counteracted by the diving-wheel operator.

CHAPTER X

Tests off Long Island.—Clara Barton as a passenger. —Crew unconscious from escaped gases.—Mice as a submarine barometer of gas leaks.—Erratic behavior of torpedoes.—The diver who became a floating balloon.

As Holland's plans now engaged his entire attention, the conduct of further trials was delegated to me. Reconstruction work, necessary to improve the *Holland's* efficiency, occupied us for some months. These changes included cutting part off the stern, putting the propeller forward and the rudders aft. We decided that the after dynamite gun was useless and removed it.

Up to that time no provision had been made for torpedo compensation, a subject already alluded to in a previous chapter. In a submarine boat of this size compensation for weights was very important. In other words, when the boat was once trimmed for diving, no additional weight could be taken in or expelled without affecting the boat's trim. When a torpedo was fired the tube instantly filled with water. To maintain the trim this water had to be kept in the same relative position. Hence it was necessary to install compensation tanks, in which the water from the tube could be blown or pumped in order to load another torpedo. Each compensating tank held a weight of water corresponding to the weight of the torpedo. The steering gear had also to be rebuilt and rearranged.

These changes were completed about April, 1899, and we were again ready to begin our under-water work. While we were passing through this period of rebuilding, many of the people who were financing the enterprise became dissatisfied; they could not understand why a submarine boat, once finished, required improvements. They were told that if they desired the project to proceed to a successful end they must leave the engineering staff alone. This advice was taken.

No satisfactory experiments could be undertaken anywhere around New York, owing to traffic, shoal water and other obstacles. Searching for a good practice ground, we decided that Peconic Bay, a few miles above Greenport, Long Island, was an ideal spot, with New Suffolk as our location. There, early in June, we removed our entire outfit on a steam lighter with the little *Holland* in tow.

Our first shop, which we built ourselves, was a one-story building seven by nine feet, and cost, when completed, about thirty-five dollars. Before the season was over, we outgrew it and rented another building close by, for which we paid four dollars a month rent, an excessive sum, but we needed the building.

Our program embraced putting the *Holland* through her paces to fit her for undergoing a series of further trials the Navy Department had mapped out. The tests were much more elaborate and difficult than any she had so far endured. Betweentimes we would give public exhibitions for the benefit of representatives of foreign navies, newspaper men, and some of our friends. Some of these runs were more or less exciting.

On one of these trips we had Clara Barton, founder of the Red Cross, on board as a guest. Perhaps she was the first woman—certainly she was among the first of her sex—to venture in a submarine. We ran the *Holland* for several miles on the surface, then submerged her—and Miss Barton—to a depth of fifteen feet on a run of two miles. Holland explained to her the boat's mechanism, particularly the operation and effect of the torpedo. If he looked for congratulations on his ingenuity, he did not get them. On the contrary, she expressed her great surprise that any American citizen should be guilty of inventing such a deadly instrument of war. Holland, with his usual Irish good nature, assured her that to take life was not the purpose of the boat, but rather the contrary. He believed that if all the nations of the world were equipped with submarines there would be no war. The World War proved that he erred in this belief.

Had Miss Barton been on board on another occasion, her disapproval of the submarine as a deadly weapon even in peace times would have been sustained by experience. We had arranged to give an exhibition for the benefit of U. S. Senator William M. Stewart of Nevada, and Major-General M. C. Butler, of South Carolina, together with several representatives of foreign governments. The program provided for a surface run of several miles, a submerged run of two miles, a torpedo attack on an imaginary enemy, and a flight under sea. The exhibition was intended to prove that if the unsuspecting vessel was anchored she would have gone to the bottom as the *Maine* did in Havana harbor.

I was in command with a crew who had frequently navigated the ocean bed and had become fascinated with the work. At the end of the first mile under water we came up for observation, having no periscopes. Our conning tower remained exposed only five seconds, during which I gauged the distance to our target and disappeared. The torpedo we used, the regulation Whitehead, was discharged 600 yards from the imaginary ship. Immediately after firing we turned, still submerged, and disappeared. The torpedo made an accurate run and struck the imaginary ship squarely in the center.

The exhibition over, we brought our boat to the surface and started on the return trip. The Holland's engine was not reversible, and in order to make landings it was necessary to disconnect it and couple the electric motor to the propeller. The run home was made without a hitch. When about 500 yards from the dock where we were to land, I gave the usual signal to disconnect the engine and connect the motor. At that time I had three men in the boat and two on deck. Immediately after the signal was answered my chief machinist reported that the engineer had fainted away. I had him brought from the engine room to the conning tower, the only opening in the boat for fresh air, whereupon I heard the chief machinist say, "I am going, too!" Immediately he became unconscious. These two casualties left only one conscious man in the boat, the electrician in charge of the main motor. As we neared the dock I gave the signal to stop the motor. The electrician answered. Then I gave the signal to reverse the motor. This was also answered. But my order for the stop signal brought no reply. The last man below deck had become unconscious.

I dropped down from the conning tower, walked aft, a distance of about twenty feet, and stopped the main motor. Before I could get back to the conning tower, it was my turn to collapse and join my unconscious crew.

Meantime the men on deck had succeeded in getting a line ashore and making the boat fast. A number of people on the dock watched our maneuvers and several scrambled on board to rescue the men below, only to be themselves overcome in the boat. Finally, all the men, now eight in all, were brought out, and lay on the dock unconscious, nearer dead than alive. One by one they regained consciousness with medical aid, but it took about four hours to bring the last man back to life.

The talk went that this was the last of the submarine. The crew would never be tempted to enter the boat again. But every member reported for duty on time the next morning.

Their mishap was due to a leaking exhaust pipe admitting gases into the boat. This was one of the most troublesome defects we had to contend with in the early days of submarines. We could find no means of indicating the presence of this gas. For several years we spent thousands of dollars and much time trying to do so. At last we resorted to the old-fashioned mouse test, which merely consisted in keeping a cage of mice in the boat. When the mice died it was time to go ashore. A cage of mice has been handed down as one of the important adjuncts to a successful submarine.

By the middle of October we were confident that the boat was in perfect condition, the crew thoroughly trained, and the skipper experienced enough to handle the craft to the satisfaction of the Navy Department. The latter was so notified, and on November 6th a special board of naval officers assembled at New Suffolk to witness the trials. Despite the burning out of two sections of our main motor armature, caused by a deterioration of the insulation (traceable to the effect of the salt-water bath the boat received in dock three years previous), the trials were a noteworthy success. The *Holland* returned to her berth with a large new broom lashed to her mast.

We had passed through months of dangerous experimental work. Every day brought a new problem; we never knew what was going to happen next; we were never sure, on starting, that we would return. Yet our men never hesitated. For them teaching a submarine to do its work was a fascinating adventure.

Once we made a two-mile submerged run, and on coming to the surface were hailed by a fisherman.

"You fellows better look out," he shouted, "or the undertaker in this town will be working overtime."

He told us that while running submerged we had missed a huge rock by inches. His statement was correct. Thereafter we were watchful of hidden dangers, but could never be certain of where they lay.

We were not always sure of the behavior of our torpedoes. Out on a trial, we charged the torpedo—a regulation Whitehead of the older type—with the customary amount of compressed air, and placed it in the tube ready to fire. The boat was sealed and water admitted to the ballast tanks, until we were awash with only the conning tower perceptible above the waters of the bay. When the torpedo was fired I could see, from the deadlights in the conning tower, the white wake as it sped on its course. An instant after a column of water shot into the air directly ahead of me. Evidently the torpedo was not acting according to regulations. I put the helm hard over, blew out one water ballast, and came to the surface. The column of water was still spouting; that told me the torpedo had struck bottom and was operating there fast in the mud. For some unaccountable reason its diving rudders had refused to function and the torpedo accordingly turned tail upon being fired, headed for the sea-bed at a speed of about thirty miles per hour. We immediately dropped a buoy to mark the place and returned to our base.

As these torpedoes were worth five thousand dollars, we could not well afford to lose them. A diver spent a fortnight searching the bottom of the bay, for the missing weapon, without success. As a last resort a member of our crew donned a diving suit and went down. Slowly he sank to the bottom of the bay. In about thirty seconds a dark object shot to the surface. It looked like a diving suit, but about four times its natural size. It appeared that the relief valve on top of the helmet had caught, allowing the air from the pumps to accumulate in the suit, causing so much buoyancy that suit and man came to the surface like a skyrocket. The conduct of the diving suit was on a par with that of the erratic torpedo. The latter had produced a geyser, the suit an under-water balloon. The helpless man contributed a geyser of language which added to the gayety. The helmet was adjusted, the man again went over the side, and within ten minutes the torpedo was located and hitched to our painter in tow to our base.

The whimsies of those early torpedoes as catapulted from the little *Holland*—which might have been at fault, too—were as unseemly as the delinquencies of a recalcitrant child. In our target practice the uppermost question was, "What will she do now?" We never knew before the event. In familiarizing ourselves with handling and operating torpedoes, we would start two miles from our target (which consisted of buoys placed 300 feet apart, to represent the length of a small war vessel), running at full speed on the surface. When about 600 yards from the target we would discharge the weapon. The mechanism of the torpedo was always carefully adjusted. We would place our little steam tender at one side of the target to pick up the torpedo when it had finished its run. On one occasion it made a straight run and passed through the center of the target. So far it had acquitted itself well. But it then took a quick turn at a right angle, made a complete circle around our tender, and aimed for us like a boomerang. Only swift action by us prevented it from sinking the submarine which had sent it forth.

CHAPTER XI

The *Holland's* royal progress from Long Island to the Potomac.—Curious crowds *en route* attracted by the wonder boat.—Insatiable public curiosity.—Guarding her secrets.—Storage-battery problem and security from gas explosions.—Washington trials to win official support for submarine development.—Obstructive sightseers on private craft.—Regulating the boat's trim for fresh-water navigation.

THE *Holland* was next scheduled to give some exhibitions in the Potomac River for the enlightenment of the government folks at Washington. This engagement meant a trip of nearly 500 miles, the longest any submarine had undertaken up to that time.

On November 9th we left New Suffolk, and tied up in Greenport for the night. The next morning we were under way at daylight. There was a forty-mile gale blowing and the storm signals were set for something worse. When we reached Plum Island we decided that we would be happier in Greenport harbor than in cruising about Long Island Sound in a fifty-foot submarine, and back we went, waiting for better weather. Two days later, in good climatic conditions, we made a comfortable trip to New Haven.

The next day we reached New York, where

the insurance companies refused to cover us for an outside trip to the Chesapeake capes. As we could not afford to take any risks, we chose the inside route (now a part of the proposed inland waterways) *via* the Raritan River to New Brunswick, through the Delaware and Raritan Canal to Bordentown, down the Delaware River and Bay to Delaware City, through the Delaware and Chesapeake Canal to Chesapeake City, down the Elk River to Chesapeake Bay, following the bay to the Potomac River, and up the river to Washington. An eager and curious populace awaited us at each of these points. The coming of the *Holland* was an event.

As the *Holland* was drawing about eight feet of water, and the maximum depth of the Raritan Canal is only seven feet, it was necessary to place pontoons on either side to lift her about eighteen inches above the normal water line. These pontoons were of wood and heavily timbered to withstand any shocks to which the boat might be subjected in passing through the canal. All this work was done at Elizabethport, New Jersey, where the boat was built. On December 2d we left Elizabethport, and late in the afternoon that day entered the first lock of the canal at New Brunswick, tying up there for the night. Here we found several hundred people on the dock waiting to behold the submarine wonder. Many had been there for hours. We were under way at daylight the following morning, and as we passed through various towns crowds numbering from 50 to 5,000 people lay in wait.

At Princeton the onlookers began to assemble at the canal about noon (at this point the canal is about two miles from the town proper), and waited patiently until dark, when word came that we were berthed for the night six miles distant. At midnight our watchman turned us out to report that so great a crowd had assembled that he was getting nervous. Apparently half the inhabitants of New Jersey had gathered on the banks, armed with all manner of lights, in their eagerness to see the boat. Most of them appeared to be workmen employed during the day who could not restrain their curiosity and meant to gratify it before the boat passed on.

The inquisitive ones pressed forward and asked numerous questions. Did the boat go entirely out of sight? How far could we see when entirely submerged? What did we do for air when we were beneath the surface? One of our crew was always on hand with ready answers to such questions. The wise-acres must be made wiser. Each of the crew, he told them, carried a small bottle of liquid air, and when he felt the air in the boat becoming vitiated he would touch his tongue with a drop of the liquid, which sustained him for a long time. This explanation served. After spoiling our night's rest, the crowd slowly dispersed. I imagine some of them talked about that midnight excursion for long after.

Our largest crowd awaited us at Trenton. Most of the shopkeepers had closed for half a day to give their employes a chance to see the boat, and the docks and canal banks for three miles were black with people. At Bordentown, where we locked out in the Delaware River, we found the public schools closed in honor of our arrival and most of the children assembled on the docks. At Philadelphia, where we remained a week, we found it necessary to ask the police department for a guard night and day. We were flooded with requests from the public schools and various city organizations for passes to inspect the boat. But the boat was only on view from the outside.

The *Holland's* next laps took her to the

Chesapeake Canal, then to Chesapeake City, and down the Elk River into Chesapeake Bay. Here a gale of wind struck us and we were obliged to find a lee under the western shore of the bay and anchor till the wind died down. The next day we were at Annapolis, where we told submarine stories to the Naval Academy cadets, and the day following we tied up at the Washington Navy Yard on the Potomac River, thirty-nine days after our departure from Greenport. If ever a crew was glad of a good night's rest in a real bed, that crew was the *Holland's*.

Our winter's work here was designed to arouse the confidence of Congressmen, naval officers, and the public in the practicality of submarine navigation. We had reached a stage where we must demonstrate that submersibles were vital auxiliaries of the American navy. Consequently, we set about giving the *Holland* a needed overhauling after her six weeks' trip. While *en route* little attention had been paid to grooming her. She was so far from being in shipshape that some of our efficient housekeepers would certainly have criticized our methods, had they been allowed to examine the boat's upkeep. But we were safe. Up to that time no ladies—except Miss

Barton—had been allowed on board. We were not borrowing trouble in that quarter.

The usual crowds flocked to the navy yard, hoping to obtain a view of the inside of our strange craft. The yacht *Josephine,* our convoy, had been moved alongside the dock and the little *Holland* was tied outside of her, completely hidden from the shore. No one had access to the *Josephine* except workmen and the crew of the *Holland.* Our visitors dispersed, sorely disappointed.

I suspected that many of them lay awake at night devising pretexts that might enable them to get even a glimpse of the mysterious submarine. One instance of an ingenious curiosity was provided by a newspaper reporter who had ascertained that we were using an Otto gasoline engine built by the Philadelphia firm of that name. He came to me claiming that he represented the company, who, he said, had sent him to examine the engine. I asked him if he knew a certain man connected with the company, giving him a fictitious name. Yes, he knew him very well; had seen him only the night before. I told him he had not, and demanded what he was after. Of course he got no news. Years after I met him on the street in Petrograd. He had not forgotten his first attempt to enter a submarine. This was an example of the many subterfuges resorted to by newspaper men and others to get on board our wonderful little boat (at least, so we considered her).

In the end we had to place guards at the navy yard to hold off visitors. These guards had never been inside a submarine; had, in fact, never seen one before. Hence they imparted the right kind of information to the inquisitive public. It was amusing, as well as misleading, and accordingly served our purpose of protecting the *Holland's* secrets. Moreover, the answers satisfied visitors and relieved our working force from the responsibility of disclosing information.

Our men were otherwise engaged in reconditioning the *Holland* after her long and tedious trip (long in time but not in distance, tedious because the little boat was never built for long cruises and her accommodations were narrow and confined). It was a protracted and irksome task. The engine had to be taken down and each part not in perfect condition either repaired or renewed; the electric motors had to be tested and parts that showed weakness replaced. The storage battery, which was, and is to-day, the most important element in a submarine (because it is the only source of power for propulsion while submerged), had to be examined and a part of the installation renewed.

The battery in this boat, as in some of our later vessels, was the most troublesome part of our equipment. As nearly everyone knows, a storage battery consists of a series of lead plates immersed in a solution of sulphuric acid. In the earlier submarine installations the jar in which these elements were placed consisted of a skeleton frame of steel entirely covered with sheet lead. They were placed in the boat in rows half an inch apart, the space between them filled in with wood strips for insulation, as each had to be insulated from its neighbors. The wood was treated with acid-proof paint before installation, but in spite of this protection, the acid fumes in a short time would attack the wood and cause trouble. Eternal vigilance on our part kept us from shortening our existence. A storage battery when charging gives off large volumes of hydrogen gas, which is highly explosive. Without careful attention to ventilation and adequate means for carrying off the accumulation of gas, an explosion was liable to occur at any moment.

We never had a serious accident. Personally, I am very proud of a record, covering a period of twenty-five years in submarine work, in which we have never lost a life or had a man seriously injured. In the early days, and up to 1910, we not only had storage-battery gas to contend with, but also the danger arising from large quantities of gasoline confined in tanks and pipes, which were liable to leak. Escaped gasoline would flow directly to the bilge of the boat, and in this confined space would give off a certain amount of gas that might readily become ignited. This occurred frequently in foreign submarines, and in a few instances in those of our own navy.

In Holland's first boats his only means of propulsion under water was an oil engine. For combustion, he was obliged to use compressed air, but as he could carry only a small amount of air, the length of time he could stay submerged was limited. When the storage battery came into use, he considered the problem of staying under water solved. In a measure, this was true, but when the danger of hydrogen gas explosions became apparent, we looked for some less dangerous means of accomplishing a desired end.

About the beginning of 1900 the *Holland* had become in the pink of condition and ready for exhibition runs. Our next step was selecting a suitable trial ground. The chart showed us an available run just below Fort Washington, about twelve miles down the Potomac from the capital. Here we had a stretch of water five to six fathoms in depth, 400 yards wide and over a mile in length, which carried us nearly to Mount Vernon. I often thought, while running on the river bed, of the progress made in navigation since George Washington looked out from his porch on the river.

On either side of the channel at this point were long stretches of mud flats on which there were only a few feet of water at any time. We deemed it necessary to erect poles along those flats on either side, and attach white flags to them, to show us the location of the mud when we came to the surface. We did not care to get stranded in mud at the bottom of the river. It was difficult to judge distance accurately, with the observer only a few inches above the surface. Up to that time, periscopes were unknown and our only means of taking an observation was to expose our conning tower, which in our early boats was very low.

We laid out another course at Alexandria, several miles nearer Washington, for short runs. The stretch here was only a half mile in length and about 300 yards wide, with a depth about the same as that of the Mount Vernon course.

We got no further for a period. Winter set in; the river was frozen for a distance of about twenty miles and practically stopped navigation for nearly a month. We had supposed when we reached Washington that we would be in a part of the sunny South.

With the first of March the ice broke up and we began our work. The newspaper men, who had been keeping close watch of us, resumed their activities at the same time. We discouraged spectators, but there was no escaping them. Even practice runs at break of day on the Alexandria course, before people were usually out and about, did not protect us from publicity. Accounts of our movements appeared in the press just the same. Launches, rowboats, towboats, and other craft came on the scene, waiting for hours for us to appear. We had to requisition two patrol boats to keep sightseers off the course. Otherwise, we ran the risk of coming up under some craft, capsizing her, and perhaps drowning those on board, to say nothing of ourselves. The periscope obviated this danger later. On the Potomac River we encountered a new experience in operating the boat. It was the first time we had handled the *Holland* in fresh water. Her ballast equipment had been regulated for sustaining her trim in salt water. The difference of displacement between fresh and salt water (several hundred pounds) barred us from filling all the ballast tanks. Had we done so the boat would have sunk. Previous experience had taught us that handling a submarine with main ballast tanks partially filled was a dangerous experiment, as the angle of the boat in diving and rising was such as to cause free water to rush to the lowest point, suddenly increasing the weight of the boat at this point and impeding her control with the horizontal rudders. The *Holland,* as originally designed, had three main ballast tanks, one forward, one amidships and one aft. After our first experiment in fresh water we had to fill the after main ballast tank with block cork, carefully packed and cemented in with marine glue, then to adjust lead ballast, which for our work in fresh water remained permanent.

This readjustment of ballast for fresh water was a vital necessity if the *Holland* was to prove her fitness for adoption by the navy.

CHAPTER XII

Naval skepticism.—Commander Kimball's support. —Official trials of the *Holland*.—Avoirdupois of congressional passengers upsets boat's trim.—Thrilling descent stern foremost.—Japanese interest.—Ruse of naval officer to take a submerged run unknown to his wife.—How the air pressure (real air) affected a Congressman.—A submarine voyage not dangerous.—Educating the official and public mind.—Dewey's favorable views.—Naval board cautiously recommends acceptance of the *Holland* and the building of further boats.—Admiral Hichborn's dissent from the board's criticisms of boat's showing.—Training raw naval crew to run her.—Evading observation from naval scouts in night maneuvers at Narragansett.

THE outlook for the *Holland* was none too bright. The last naval board which reviewed her performances off Long Island, despite our belief that she fully proved her worth, had reported unfavorably to John D. Long, then Secretary of the Navy. A member of the board, Rear-Admiral Philip Hichborn, chief of the Bureau of Construction, alone dissented, filing a minority report in our favor.

We had yet to overcome the skepticism produced by the nonsuccess of the *Plunger*, the first boat Holland built for the navy. The discredit was laid to us, though her failure was solely due to navy technicians, who had insisted on installing a steam-power plant in face of

Holland's strong objections. The steam plant was the cause of her failure, but the circumstances were never investigated. It was enough that the boat was rejected and that action condemned the whole principle of the submarine as then known.

Our supporters remained few. I could almost count them on the fingers of one hand. Among them, Commander Kimball remained one of our sturdiest advocates. Two years before, in 1898, when in command of our torpedo-boat flotilla off Cuba during the war with Spain, he asked the Navy Department to purchase the *Holland* as she was then, just off the stocks, put him in command, and order him to torpedo the Spanish fleet in Santiago harbor. Holland's plan was as venturesome. He wanted to take the boat to Havana, countermine the harbor, and shell the fortifications at close range with guncotton. But the Navy Department shook its wise head, as we suspected it was doing now, on the eve of the *Holland's* official trials to determine her utility.

Commander Kimball was among the first of the naval experts to espouse the cause of undersea protection for our coasts and harbors. Twenty years previously he encouraged

Holland when the latter was an obscure teacher wrestling with his submarine conceptions in Paterson, New Jersey. He was so impressed by Holland's early plans that he invited the inventor to discuss them with him at Washington, but lack of railroad fare proved an obstacle. Commander Kimball then vainly sought to have the Navy Department employ Holland as a draftsman at $2.50 a day. Had the department utilized the inventor's services, the government would now be in possession of all the Holland patents. Holland himself wrote of Commander Kimball that submarining owed more to him than to any other man.

The submarine at this time was probably the most talked of, and least understood, of all modern weapons of war. Yet the almost overwhelming naval opinion, as we sensed it, was that the device could never be of any military value. Nevertheless, our own confidence was unabated.

The official trials came on March 14, 1900, on the Fort Washington course, before Admiral George Dewey (a member of the Navy General Board), the heads of the naval bureaus, Charles H. Allen, Assistant-Secretary of the Navy (who succeeded Theodore Roosevelt), and a party of Senators and Congressmen. The admiral and his staff were grouped on board the naval gunboat *Sylph.* Our convoy, the *Josephine,* accommodated the congressional party.

We ran submerged for ten minutes on a straight course, exposing only the tops of our flagstaffs, to which were attached two small flags. Then we came to the surface, fired a Whitehead torpedo at an imaginary vessel, dived, turned under water, ran back submerged for five minutes to show our ability to escape from an enemy after firing the torpedo, and emerged on the surface again, with our water ballast pumped out and an open conning tower.

In submerging at the outset we disappeared in twelve seconds. The run down the river was made at a speed of about six knots with a variation of depth of not more than six inches. The actual period of our exposure in firing the torpedo and disappearing was only seven seconds.

The torpedo, after leaving the tube, made a straight run for about 600 yards and suddenly disappeared. A small boat manned by two men was stationed at the point of firing and immediately rowed to where the torpedo was last seen. They found no trace of it, after a search of several hours. Several days later we were notified by telephone that something which looked like a torpedo had been taken in a shad fisherman's net, and was lying at a small dock in Alexandria. We located the fisherman, who wanted to profit by his find. We succeeded in convincing him that he was holding government property and was liable to imprisonment. Having heard that the torpedo was worth about $5,000, he had bargained to get at least ten per cent of that sum for recovering it. We settled the award at fifty dollars.

While the Navy Department pondered over its decision, the *Holland* exhibited her points to other interested parties. Some were capitalists looking for investments; others were foreign experts. Several trips were made for various Senators and Congressmen, whom we specially regarded in view of the support they could give to submarines.

One run we made for three members of Congress was memorable. At first we ran a mile submerged, while our cautious visitors watched the maneuvers from the deck of a yacht. We had first to assure them, before they ventured in her, that the boat could be controlled. Then we emerged and took them on board to enable them to observe the boat's internal operation.

Here we made a miscalculation. A perfect exhibition of a submarine is one in which the boat submerges quickly from the light condition. Usually we effected this by first trimming the boat with a certain amount of water ballast, then blowing out certain tanks. When we were ready to submerge we knew exactly what tanks to fill to put the boat in diving trim. I had carefully estimated the weight of the three gentlemen and allowed for the amount of water ballast necessary to compensate for this weight. Either the man at the Kingston valve disobeyed orders, or my calculations were wrong. At any rate, after we had sealed our conning tower, with our visitors on board, and admitted what we supposed to be the right amount of water, the boat started for the bottom of the river, stern first, like an old anchor. Only quick action by the crew saved us from hitting the mud. Later we strove to explain to our guests that the boat's behavior was intended to show our perfect control. I do not believe they were ever persuaded that such a descent stern foremost was part of the program.

Among naval officers who watched our trials was Lieutenant Ide, a representative of the Japanese navy. He made several submerged runs with us. Later the Japanese government adopted the *Holland* submarine by ordering five boats, due to this officer's favorable report. At the same time they purchased plans for a different type of boat. Two of these were built in Japan, with Lieutenant Ide in charge of their construction.

A prominent United States naval officer was anxious to make a submerged run with us, but his wife objected. We assisted him to foil her by arranging an under-water trip at daybreak before she (and also the tiresome newspaper men) were awake. The run was successfully made and no one knew of his exploit. I do not think the lady ever learned of the risk her husband had taken. But we obtained a convert.

Less intrepid was a certain member of Congress. He wanted to make a submerged run, but confessed to a weak heart and feared the effect of the air pressure on his pulse. We assured him that the pressure would not be above atmospheric weight. So we took him on board one bright spring morning, and on reaching our trial course prepared for submergence. With the ballast tanks ready for filling, we moved further to obtain position. Meantime, our guest complained of the air pressure; he feared he might have to ask us to come up. We told him that the conning tower was wide open and that the air in the boat was the same that people outside were breathing. To him this was incredible—until he saw the blue sky through the open hatch. We could not refrain from relating this little incident with some relish. The story duly gained currency in the House, where his fellow members would ask him every morning how his air pressure was.

This Congressman's trepidation was natural enough at the time; behind it was the fear of the unknown. The safety of submarines is better understood now, yet only comparatively few people would probably venture on a long journey in one. The success of the merchant submarine *Deutschland* in crossing the Atlantic and entering the harbor at Baltimore with a cargo of dyestuffs, as well as a like exploit achieved by the German *U-53,* which quietly steamed into the Newport Harbor and anchored among our ships, was at that time wonderful only to the uninitiated. To us who had broken in the little *Holland* and who have spent the best part of our lives in the development of undersea navigation, these exploits did not seem as difficult or as dangerous as many of the risks Americans ran every day in other vehicles of locomotion and in their work.

Submarine navigation is not dangerous. I would rather steer a submersible 100 feet below the surface than pilot a passenger vessel through a dense fog. It is true that a submarine in war on the high seas becomes a bird of prey to be remorselessly pursued with depth bombs and other devices the instant she betrays her proximity by the slightest indication on the surface. In the bold exploits she undertakes, sinking to great depths might collapse her hull through excessive external pressure, caused by leaking sea valves or insecure ventilators or hatches. She might collide with vessels while on the surface, or with unknown objects while submerged; or her crew might be jeopardized by an internal explosion of storage-battery gas arising from defective ventilation. But a submarine sealed up for submerging is absolutely water-tight, capable of withstanding the heaviest seas and of safely descending to great depths. Hence sinking through water penetration is remote. At a depth of 100 feet there is little danger of collision with other vessels. On the surface the largest submarine could submerge from the light condition in less than three minutes, and when awash in less than five seconds.

Security under water was difficult to realize in the days of the little *Holland,* but her excursions beneath the Potomac for the enlightenment of official and unofficial guests were slowly educating the public mind in this direction. The boat's official exhibition produced a doughty advocate of the submarine in the person of the highest officer in the navy. Admiral Dewey himself appeared before the House Naval Committee and strongly urged that the government acquire a number of submarines at once in view of the *Holland's* showing. He told the committee that had a determined enemy with a submarine boat been located in Manila Bay he could not have occupied that harbor nor have maintained the blockade. His men were eager to fight an enemy they could see, but would not have awaited destruction from an unseen foe.

Lieutenant H. H. Caldwell, the admiral's secretary (who was in the boat with us to watch and report to him on the *Holland's* internal operation), was so impressed with her that he later resigned from the admiral's staff and was placed in command of the boat after its acquisition by the government. Thus Lieutenant Caldwell became the first submarine captain in the United States navy.

Their testimony was a propitious foretoken of the *Holland's* future, but it only embodied individual views. Collective official opinion of the navy still showed a timorous and skeptical attitude, as expressed in the majority report on the *Holland* made by the Board of Naval Construction.

The Holland Company had offered the boat as she stood for $165,000, or, with certain modifications, $170,000, and to build two new and larger boats in accordance with plans submitted for $170,000 each.

In view of the noncompletion of the *Plunger*, the contract for which, dating from March 12, 1895, stipulated this boat's completion in twelve months therefrom, the board did not recommend the *Holland's* purchase by the navy. The government had already paid $99,716 on account of the *Plunger*, and the board was of opinion that no further contract should be awarded until some satisfactory settlement was made regarding her. Subject to such an adjustment, the board cautiously indicated that the department might be warranted in contracting for a submarine boat of the larger type named for the purpose of further developing the science of undersea navigation. It seemed that the question of possible improvements to the *Plunger* had been in the hands of the naval board for several months, but the report thereon was held in abeyance, supposedly pending the official test of the *Holland*. The Holland Company had been willing to attempt further alterations to the *Plunger* without expense to the government.

A dissenting report, submitted by Admiral Philip Hichborn, held that the board had not accorded the Holland Company the credit and encouragement it deserved. The admiral pointed out that the *Holland* had been built because of the inventor's conviction that the design of the *Plunger* could be materially improved, and had adequately realized expectations on her various trials. In view of the comparatively small cost of submarine craft, the admiral urged the government to encourage their development as a measure of precaution, especially in order to have boats available for experiment and drills. He wanted the department to contract for two boats of the *Holland* type, instead of one. The *Holland,* while acceptable enough, he thought was less desirable than boats of larger dimensions. Immediate possession of the *Holland,* however, in the event of a sudden emergency, would be an advantage. On this point Admiral

Hichborn harked back to the Spanish War. He told the board that had the navy then acquired the boat, and it had reached its present state of efficiency, its presence in Cuban waters in the spring of 1898 would have had a very marked effect.

The question of the *Plunger* was adjusted and the *Holland* purchased by the department. On April 18, 1900, she was formally taken over at the Washington Navy Yard, our years of experimental work thus bearing fruit at last.

The *Holland* duly went to Narragansett Bay, where, according to agreement, we undertook to train a naval crew to handle her, meantime retaining charge of the boat until they were competent. It was toward the latter end of June before we reached Newport and tied up at the Torpedo Station.

The department assigned a number of men for training under command of Lieutenant Caldwell. Preliminary surface runs gave our crew of rookies an insight into the boat's mechanism, and, what was as important, the needed confidence in embarking upon a new method of navigation. Except the commander, none had ever before been inside a submarine. In due course we let the new crew operate in dock under our supervision. Some necessary cleaning and painting then intervened. Afterward came a number of submerged runs and the boat was handled entirely by the navy men. By September I pronounced them competent to handle her without our assistance.

With some natural misgivings I stayed out of the boat for the first time and watched her operations with her new crew. Had my heart been weak I may not have survived the experience. A submarine navigator when inside the boat, with everything under his control, can confidently confront emergencies; he knows them so well. But looking on outside the boat, where he can do nothing in case of an accident, he is in the helpless position of being unable to exercise his knowledge. In this situation I found myself during the first run of the *Holland* with the navy crew, and my trepidation was not unwarranted. Some error by the operator had caused the premature filling of the after tanks, and the stern consequently sank about fifteen feet. This meant a dangerous angle, with the bow still out of the water. It looked to me as though she was going to stand upon her tail like a spar buoy and sink. I am convinced she would have done so had not the commander promptly realized the crisis and filled the forward tanks. Thus the *Holland* came to rest on an even keel, and I breathed more freely. Henceforth the navy crew capably handled the boat and made a praiseworthy record.

Night maneuvers in Narragansett Bay demonstrated the *Holland's* agility in evading observation by watchful naval scouts. A boat selected for attack was the United States tug *Leyden,* attached to the Torpedo Station. It took up a position at the entrance of the bay, and the *Holland* set out to approach close enough to launch a torpedo before being discovered. In the first test the tug spied her in the darkness, but only because she was showing her side lights. Yet even these were not easy to discern on the dark water. The real test began with the extinguishing of the side lights. Several searchlights played over the water, and although the *Holland* was running awash she could not be seen until within torpedo range, when she hailed the tug. On another occasion, the cruiser *New York,* while at anchor in the bay with all her searchlights showing, was equally unable to find the *Holland* until the boat came within 150 feet of her. Even the big searchlight of the Torpedo Station, one of the best in the naval service, never succeeded in picking her up at night.

The time soon came when we regretfully said good-by to our little craft. We had had many ups and downs in her and had expended untold efforts for more than three years in making her justify our confidence in her inventor's genius. For a number of years she was used in the training of officers and men of the navy for submarine duty. To-day she is resting in the Museum of Peaceful Arts in the Bronx, a monument to the life work of John P. Holland.

CHAPTER XIII

The *Holland* a costly boat.—The *Adder* class.—Unfavorable comments on submarines from Admirals O'Neil and Melville.—The *Fulton* as a model for improving the new boats.—Obstacles in building her through enforced adherence to government specifications.—Theory *vs.* practice.—Misfit materials and equipment.—Speed difficulties.—Foreign naval observers.—Endurance test to prove that a crew can live for long periods under water.—Pressure of heavy tide ends test.—The gale and flood which swept Peconic Bay, with the *Fulton* safe underneath.

THE *Holland* passed to the navy for the sum of $150,000; she had cost her builders $236,615, due to interminable changes in practice and equipment, many of them almost finicky as to detail, but vital in their aggregate effect on the boat's operation. We recognized that the costly capital expenditure involved in making the boat as practicable as our then knowledge of under-water science had developed was an inevitable initial outlay. But further official encouragement beyond the *Holland's* acquisition was needed if we were to pursue our campaign of making the submarine an effective naval auxiliary. While by no means assured that the *Holland* had emerged from the speculative stage of experiment, the navy authorities conceded that they could not disregard our position and so took the risk of confiding to us a contract for the construction of six additional submarines of an improved type for $170,000 each.

These were of the *Adder* class, named from one of them, the others being the *Mocassin, Porpoise, Shark, Grampus,* and *Pike.* The first four were built at Lewis Nixon's shipyard at Elizabethport, New Jersey, the last two at the Union Iron Works, San Francisco. The Navy Department's attitude to their enterprise found expression in comments by Admiral Charles O'Neil, chief of the Bureau of Ordnance, and Admiral George W. Melville, Naval Engineer-in-chief. Both were members of the board of construction which passed upon the *Holland.*

"I recognize the fact," Admiral O'Neil declared, "that favorable comments have been made concerning the *Holland* by several eminent naval officers, for whose judgment I entertain the highest respect, but after a careful analysis of all the information that is obtainable concerning her, I am at a loss to understand upon what such opinions are based, as the *Holland* has never shown the ability to do anything more than run at a slow speed on the surface and make submerged runs of short duration at a much slower rate of speed, always in carefully selected localities and under most favorable conditions. This is the sum total of her performances, which I am unable to accept as sufficient evidence that such boats are useful and efficient instruments for naval purposes."

"The boats," wrote Admiral Melville, alluding to the *Adder* class, "are either valuable or they are worthless. From the time that the Senate and House Naval committees look with favor on these boats, there will be a decreased construction of battleships; and the action of Congress in striking out of the naval appropriation bill of 1901 all authorization for battleships and cruisers can certainly, in part, be traced to the belief that the submarine possesses many of the qualities claimed by its advocates. It is, therefore, high time that those who believe in the efficiency of the submarine should be compelled to make good a few of their promises. It is easy for them to tell of the vast amount of concentrated energy possessed by these boats, and of the ease with which this energy can be directed against an enemy. Concentrated energy, however, is usually a very awkward thing to deal with, even on a battleship. Many details as to its handling will have to be solved before it can be efficiently used in a submarine. To be able to fire one torpedo from a submarine boat, after hours and even days of preparation, is far from promising work; nor has the craft proved more satisfactory as regards stability, speed, and maneuvering qualities. . . . However sincere the builders of submarines may be, these men must of necessity give *ex parte* testimony as to the worth of their own designs."

We were loath to let the *Adder* class, which were of a uniform design, come from their stocks without the guidance of preliminary experiments to show how an improved type of the *Holland,* as these were to be, would turn out. Our knowledge of the *Holland* we did not deem sufficient for the purpose, though the new class followed her general design. Hence we determined first to build a boat of our own, the *Fulton,* as a duplicate of the *Adder* class, and for use solely to determine by tests the possibilities of her sister vessels. What new methods we discovered from handling the *Fulton* would therefore be incorporated in their equipment. In common with Admirals O'Neil and Melville, the Holland interests were anxious to substantiate their claims as submarine pioneers.

"A" CLASS SUBMARINE ON RAILWAY

LAUNCHING OF SUBMARINE "TARPON"

The *Fulton* was built at the Nixon shipyard in the summer of 1901. In dock she had her vicissitudes, and more outside. Her features bear recording, as her lines and equipment represented those of the boats which later formed the first American submarine fleet. She had a length of 63 feet, a diameter of 11 feet, and displaced 120 tons when submerged. A single screw drove her, with motive power furnished by four-cylinder Otto gasoline engines of 160 brake h. p. and by electrical motors of 70 h. p. The gasoline engine was used for surface propulsion, and also for charging the batteries, which were drawn upon by the electrical motor when the vessel was submerged. When the oil engines were charging the batteries, the motor was used as a dynamo. A single torpedo tube constituted the armament, with a provision for Whitehead torpedoes. For operating her vertical rudder and two horizontal diving rudders, the boat had separate engines, worked by air at a fifty-pound pressure supplied from six storage flasks, which carried air at a pressure of 2,500 pounds to the square inch. A reducing valve effected the necessary reduction of pressure. The boat had a conning tower twenty-one inches in diameter, protected by four inches of armor.

As a needed working forerunner of the *Adder* class, the *Fulton's* construction was pushed to enable us to run trials and obtain the desired data for successfully completing her sister vessels, which were already in frame and plated at their respective shipyards. Numerous changes found necessary impeded her progress. We had a chief engineer who, though a brilliant technician, had no practical experience in submarine construction. Theories, apparently, should prevail in a new field of navigation. Much of the mechanism designed to go into the boat was left out, and most of the mechanism left in was changed. This not only delayed completion, but entailed great expense. The *Fulton's* construction was not troublesome in so far as it related to our contribution to her completion. The difficulty was that as a replica of the *Adder* class, built in advance of the others at the Nixon shipyard, the boat in her fundamentals had to follow government specifications, and labored under the disadvantage of having technicians not of our choosing. She was not a naval vessel, but an experimental understudy intended for our operation, yet, as in the case of the *Plunger,* she was not our own child in certain essential features.

In our original uniform design for these boats, the main motor and engine were connected to the tail shaft through a chain of spur gears and a jaw clutch. These gears and clutches were made of cast iron, despite my strong objections, grounded upon experience, to the use of this material. Our chief engineer insisted that cast iron was suitable for the gears and clutches and my protests failed to change his view. An occasion came after the *Fulton's* launching when I sent the chief machinist into the boat to start her engines. Presently he reappeared with blood streaming down his face. A large chunk of cast iron he brought with him told the story. One of the gears had broken and a detached piece struck him in the face, causing a serious abrasion. Thereupon we determined to have no more cast-iron gears or clutches. The change cost thousands of dollars and considerable delay.

The same material was selected in making the Kingston valves, which were used for admitting water ballast from the sea to our tanks. The body of these valves was inside the boat proper. If one should break it would mean the sinking of the boat and loss of the crew. These cast-iron valves I refused to operate, and firmly withheld submerging the boat until safeguards had been provided to protect us from their liability to break. This imperative change also caused additional expense and delay.

Another foolish adoption was the steering and diving engines to operate with compressed air. In our experience with the old *Holland* they had proved to be useless. Although built for the *Adder* class, they were never installed. Yet another undesired feature built for the boat was an auxiliary pump of large capacity and high pressure, operated by a 10 h. p. motor, as an addition to our regular pumping equipment. It took up about half of our available space in the boat (which at best was very small) and I condemned it as unnecessary. The equipment was purchased but never installed.

The boats were designed to operate in either salt or fresh water. In common with the *Adder* class, the *Fulton* was to carry five torpedoes, with the necessary compensating tanks. In our first trials we found the *Fulton* would not float all the equipment. We had to leave out the two after torpedoes, nearly half the air flasks, and block off part of our main ballast tanks. All this meant more expense and delay which could have been avoided had our theoretical technicians been guided by the practical experience of our organized forces.

Early in July the boat was far enough advanced to leave her dock and was towed to our New Suffolk testing station, where our plant had been greatly enlarged. There we had a crew of competent mechanics at hand to complete her, and within a month we were able to make our first run. She was designed for a speed of seven knots on the surface, but the best we could get was less than six. Either grave mistakes had been made in calculating her speed, or her propeller was inefficient. We decided that the propeller was at fault and enlisted the services of several propeller experts, from whom we obtained three designs, which we built and tested, and selected the one that gave us the required speed. We tried every known method to increase this speed. Meantime, the Elizabethport shipyard had managed to turn out the *Adder,* which was brought to our testing station late in the summer, so that we could adapt her to advantageous changes we made in the *Fulton.*

Not being a United States war craft, the *Fulton* was available for exhibition before representatives of foreign navies who were attracted by the submarine as a weapon of defense. We made surface and submerged runs for several experts sent by the Dutch government, one of whom was Admiral Tadema, chief of their Naval Staff. Commander Beklemisheff of the Russian navy was another visitor who went under water with us. I little thought at the time that later he would be in command of the *Fulton* and that I would be instructing him in his own country.

A familiar question was revived over the *Fulton* by the doubting Thomases. How long could a crew live in a submarine sealed up on the amount of air usually carried? Our business was to remove misgivings, and we put the boat under water in an endurance test of fifteen hours late in November. The amount of air the boat carried was about thirty cubic feet at 2,500 pounds pressure per square inch. The actual cubical contents of the hull proper was about 2,500 cubic feet. In addition to our own crew we took down Captain John Lowe, U. S. N., and Lieutenant Arthur McArthur, U. S. N. The boat had been thoroughly cleaned, bilges washed out, and everything put in shipshape. Provision for two meals were laid in to cover fifteen hours immersion, including a bottle of Scotch whisky. While some of us did not think this stimulant necessary, others deemed it important.

The occasion was not one we would select for a holiday excursion. The night was dark and rainy and a strong northeast gale was blowing across Peconic Bay, our practice ground.

We went under in a gathering storm at seven o'clock in the evening. Our crew were assigned to four-hour watches, and at ten o'clock all hands, except the watch, turned in. About every hour during the night Captain Lowe would wake up, inspect the boat, including the bottle of whisky and return to his berth.

By six o'clock the next morning our depth gauges revealed that we were farther down in the water than we should be normally. We were resting on a hard sandy bottom and could not understand how the boat should be in deeper water than the bay's known depth hereabout. The deadlights of the conning tower showed that the water, which we had found comparatively clear in the bay, was getting discolored by mud. Everyone on board held a different view of the cause.

The change in the depth was due to an abnormally high tide, which placed several more feet of water above the boat than there would be normally. I decided it was no place for us. At ten o'clock I entered the conning tower and gave orders to blow out ballast. The boat immediately shot to the surface.

Looking out through the deadlights before opening the hatch, I discovered that we had come up under an overturned catboat, which was lying across our stern. The dock to which we were tied when we submerged had disappeared. The tide had risen some six feet above maximum high water, swamping the dock and flooding the town of New Suffolk over an area of several hundred feet, including our plant, which was normally five feet above water. Our only way home was by a small boat rowed up the main street.

The fiercest gale for forty years had swept over the bay while we were under water, but the *Fulton* neither rocked nor rolled or otherwise felt the violent disturbance on the surface. The muddy water about us furnished our only barometer of conditions overhead.

Thus we kept six men beneath the waves fifteen hours. The only air we breathed was the atmosphere in the boat when we submerged. We had no need to draw on our reserve supply.

The test brought us hundreds of inquiring letters, the writers including chemists and college professors. Many frankly doubted the story published in the press that six men had lived fifteen hours on 2,500 cubic feet of free air. Some experts told us that it was impossible for one man to live half that time under such breathing conditions. I am persuaded that these doubters suspected we had secret means of obtaining fresh air from the surface.

CHAPTER XIV

The *Fulton* sinks in dock.—Crew's escape through air pocket.—Patched up, she proves the submarine's capacity for open-sea voyages.—Sets out for Chesapeake capes from Brooklyn in heavy weather.—A crowded craft.—Life preservers as a bed on a torpedo tube.—Deck crew up to their necks in water.—Puts into Delaware Breakwater.—An interrupted breakfast.—Explosion, due to ignition of battery gas, blows a naval officer out of the conning tower like a cork.—Lacerated scalps and faces.—The shoes that landed at the bottom of a firkin filled with sugar.—Conduct of a coffee pot.—The *Fulton* out of commission.

We were to proceed to Washington to give more exhibitions in the Potomac for the purpose of further stimulating official interest in our work. The *Fulton* was overhauled and meticulously groomed for this event, a laborious task that kept us working day and night. By the 1st of December she lay spick and span, primed for being put again on her mettle before the powers that control appropriations—and then sank in the night. I was temporarily absent in New York when word came that she was lying at the bottom of the bay. There were three men in her, but they succeeded in getting out. Mildly expressed, this was discouraging, after our labor in putting her in condition. Wreckers were requisitioned and twenty-four hours after the *Fulton* was again on the surface, much the worse for her salt-water bath.

It appeared that the workmen had had occasion to hoist up the stern of the boat with a crane, but in doing so left the main hatch open. During the operation the boat dropped, putting the hatch under water. The three men in the boat struggled to get out through the inrushing water. Two of them succeeded. Finding afterward that their shipmate had not escaped, one of them returned to rescue him while the water still rushed through the hatch. Once inside, he seized his mate and succeeded in getting both their heads above water in an air pocket, a device provided for just this purpose. There they waited until the water ceased entering the hatch; then they maneuvered out of their air pocket and came to the surface.

The *Fulton's* electrical apparatus, which had taken months to install, was practically ruined, as were the storage batteries. The boat was temporarily patched up for her tests, our purpose being to complete her reconditioning and make permanent repairs afterward. The patching up was done with disastrous results.

While her repairs were under way, British interest in submarines called me to England,

and it was April of 1902 before I returned to resume control of the exasperating *Fulton*. In my absence she had been placed in what we supposed was a good working condition, ready for the trip to Washington. Assured of this, we left New Suffolk on April 24th, late in the afternoon, tied up in Greenport for the night, ran down Long Island Sound the next morning, and the following day reached South Brooklyn.

Here we were called upon to overcome more skepticism regarding the powers of the submarine. Statements were made that while our boats might operate in harbors and still waters, they would be useless at sea. We thereupon made a submerged run out into the broad Atlantic from South Brooklyn, heading for Delaware Breakwater. We had as convoy our own steam yacht, which carried our supplies. In addition, as the insurance companies compelled us to charter an ocean-going tug, we had the *Storm King*, which hailed from Boston.

We first headed for the Scotland Lightship. A few miles to the southward of this light we stopped and prepared the boat for submerging. All the top hamper, such as the portable deck, ventilators, and guy lines, was stowed on our tender. Thus decks were cleared for the submerged run, which lasted about an hour. To us there was nothing untoward about this test, but it served its purpose in demonstrating that the boat could be operated with success in the open sea. Our portable gear was then replaced for the coastwise run south.

For this voyage we had a crew of eleven men, with three naval officers, two American and one Austrian, as observers, and supplies for about two weeks. In a boat the size of the *Fulton* fourteen men with supplies made a load which left little room for sleeping accommodation. The men who were not on watch had to curl up in any cavity they could find. My bunk was a few life preservers on top of the torpedo tube.

Our course was laid for the Chesapeake capes in fine weather, with a light breeze blowing offshore, and no sea. Our cruising speed was only about six knots; hence our progress was slow, but the boat's mechanism functioned without a hitch.

In the night the wind shifted to the southeast, increasing toward morning to a small-sized gale. About 3 A. M. rain came with an increasing sea; at 4 A. M. the watch called me on deck, as the weather was getting worse.

The boat in light condition had only a small amount of freeboard; the conning towers were low in the water, and a small sea would wash over it. I saw the necessity of battening everything down, leaving as the only opening a small ventilator which we needed to furnish air for the engines.

On reaching the deck the sea was practically up to my shoulders. The *Storm King,* thinking that we were making heavy weather and in a dangerous position, tried to come alongside and make a lee for us. I immediately ordered her off. I had no fear of our little boat in the open sea with nothing but water around her, but the *Storm King's* close proximity might bring the two boats together and cause serious trouble. For the next few hours we made slow progress. The men on deck were up to their necks in water most of the time.

The course we were taking for the Chesapeake capes carried us some distance from Delaware Breakwater. About 9 A. M. we sighted the breakwater, our convoy some distance in the lee. Chesapeake capes lay more than one hundred miles distant and there was no harbor intervening. So the breakwater, after the hours we had been wallowing in the sea, looked like home. There we hauled in and anchored back of the stone pile. Inside, the water was as smooth as glass.

Wherever we made port our steam yacht also anchored, and we would tie up alongside her in order to have access to her accommodations for our men. Inside the breakwater I signaled to stop our engine and waited until the yacht had anchored, so that I could tie the boat alongside. Three men were on deck, including myself, and eleven inside.

Meantime, the men below decided to prepare breakfast. Our cooking was more or less of a camping job done on an electric stove. On one stove was our coffee pot, which held about two gallons; on another the men were boiling eggs. Some of them had already started their meal.

While we drifted and waited for the yacht to anchor, with our engine running light, I heard on deck what sounded like a heavy explosion some distance away. Just then one of the United States naval officers appeared halfway out of the conning tower trying to come on deck. As he carried a considerable avoirdupois, he fitted the conning tower very closely. He duly got on deck, but not by his own volition. He was blown from the conning tower like a cork.

I realized then that the explosion was inside the boat. We were helpless, and signaled the *Storm King* to come alongside and make fast, which she did. The first man who emerged from inside the boat was one of our own crew, whose condition was such that I thought he had only a few minutes to live. One side of his scalp was torn off and blood drenched his face, well mixed with the contents of a soft-boiled egg. The next man had a broken nose. The third's face was deeply gashed and streamed with blood. The other eight men escaped injury.

The explosion was due to the ignition of battery gas. It had lifted the main deck, where were located all our supplies. The deck was practically firewood.

Before the mishap one of the United States officers had exchanged his shoes for sea boots. The discarded shoes lay on deck and vanished with the explosion. Later we found them in the bottom of a butter firkin which we had filled with sugar. The firkin was of the kind used for butter in a grocery and held five gallons. No one could explain how the shoes found their way into it underneath the sugar.

Calling the roll produced a fourth injured man, who seemed more or less dazed. His impression was that a part of the engine had struck the crown of his head. An examination showed that he was saturated with coffee, which revealed what had struck him. The steaming coffeepot on the stove had been blown up and landed topside down on his head.

Our casualties did not prove to be serious except those which the *Fulton* sustained. She was put virtually out of commission. For the Washington tests she was replaced by her sister craft, the *Adder*, a government boat, which by now was almost finished.

CHAPTER XV

Holland and Great Britain.—Submarine devised to damage British sea power is adopted by the Admiralty.—Disbelief in the new sea weapon.—Trying out the boats at Barrow.—Admiralty unwillingly recognizes necessity of an American crew.—Misgivings inexperienced British as to getting back after submerging.—Tests in the Irish Sea.—Careless discipline by British officers causes explosion.—The smoking peril.—Officially hoped that submarines would fail.—Navy resents their introduction.

FOREIGN interest in our activities had, as early as 1899, attracted the attention of Great Britain. The little *Holland* was then arduously feeling her way toward her utmost efficiency. Her achievements, withal imperfect enough—too imperfect, in the view of our Navy Department—had sufficed to animate the slow-moving mind of the British Admiralty. It was a furtive interest, officially kept very dark indeed, so much so that that body refused to acknowledge that the submarine merited serious consideration in the field of practical navalism.

Holland himself devoted much of his energies toward stimulating foreign consideration of submarines while I was demonstrating in American waters the practicality of each boat we produced. About this time he was in England in consultation with naval and shipbuilding officials. The humor of such a contact could not have been unrecognized by either party. The man who had set his heart on devising an instrument to cripple Great Britain's sea power had seen the way open to introducing his device into her navy, not as a destroying foe, but as a protecting auxiliary. However, the *Fenian Ram* of 1881 was veiled in the mists of oblivion, and the veil was not lifted. Had that strange craft been mentioned, one could imagine Holland and the British Admiralty exchanging humorous glances. But there is no record of such an interchange.

Great Britain was not disposed to depend on the experience of other powers for guidance in the adoption of submersibles. But the Admiralty quietly and leisurely weighed the whole question, taking two years to do so, meantime obtaining all the data available before determining that an ounce of fact, obtained by its own experience, was worth a ton of theory derived from what other nations were doing. While lending a listening ear, it declined to attach an exaggerated importance to submarines. The prevailing official attitude was that Great Britain had no need of such boats.

"If the development of the submarine had made any substantial progress," wrote Admiral Melville (United States), "it is to be presumed that the British Admiralty would have utilized this craft long before now (1901). The British estimate of its usefulness may be measured by the manner in which her naval writers refer to the boat."

This was an allusion to the remarks of a naval gold medalist of the Royal United Service Institution, whose views, the admiral said, were identical with those of most British naval officers:

"Submarine boats are a confession of weakness and by no means to be recommended by our navy, whatever foreigners may think about them. Both the Americans and Spaniards were in possession of boats of this class during the late war (1898), but as neither attempted to make any use of them, we may perhaps be permitted to conclude that they did not think they were worth the trouble of transporting to the scene of action.

"Although a very large number of a variety of types have at different times been invented and experimented with, the results of their trials, although often reported as eminently satisfactory, have never been such as to lead to their construction on any large scale. Their use, too, has been condemned for what now, perhaps, would be scoffed at as sentimental reasons. But it may be remembered that even Napoleon, who was not particularly troubled by scruples of this kind, refused to employ the fairly successful boat invented by the American, Fulton, against the British fleet, while his admiral, Decres, remarked that such craft were only fit for Algerines and pirates. France, however, has several in hand, probably more with a view of pleasing the fancy of the public than from any real expectation that they will be of any particular value to the navy."

The British naval estimates of 1901, however, provided for the building of five experimental boats of the Holland type. The Admiralty, though deciding on this outlay, remained unconvinced of the submarine's utility, but apparently yielded to an outside demand that a few be constructed.

"What the future of these boats may be in naval warfare," the Admiralty reported, "can only be a matter of conjecture. Experiments with these boats will assist the Admiralty in assessing their true value. The question of their employment must be studied in all its developments and their mechanism carefully watched in this country."

The boats, which were uniform in general features with the *Adder* class, were built by the firm of Vickers, Sons & Maxim, of Barrow-in-Furnace, Lancashire, who had acquired the sole rights of manufacturing the Holland submarines outside the United States. The boats were duly adopted after comprehensive tests, in which I shared as instructor. The Admiralty confined all their submarine work, both in experimental design and construction, to this firm. The arrangement involved secrecy, as the government required in their contracts that the firm should not undertake to build submarines for any other nation. Foreign powers were thus prevented from gaining the benefit of the research work and experimenting which the firm undertook in connection with the Holland boats.

In face of the activity of rival inventors, the fates had decreed that the builder of the *Fenian Ram* should have the sole privilege of providing submarines for the British navy. The Admiralty's action in placing the order did not pass without comment in the House of Commons. "If we are to dabble in submarines," the government critics said in effect, "why favor the devices of Mr. John P. Holland of the U. S. A.? Why not invite designs from other firms in competition?" Mr. Arnold-Forster, Parliamentary Secretary to the Admiralty at the time, explained that when the decision to construct submarine boats was arrived at, only one type (the Holland) was then available for purchase. The right to build that type was in the hands of one firm, to whom it was necessary to entrust the work.

The arrangement was due to the fact that Isaac L. Rice, president of the Holland Company, who made the contract with the Admiralty, wanted to save the expense and risks of transportation involved in building the boats in America, and therefore looked about for a British shipbuilding firm who could produce the craft.

Our part in the contract was to furnish plans and a superintending engineer to overlook the construction of the boats, conduct trials, and train an English crew. The engineer we sent (one of our own staff) was a naval architect and engine designer, an Englishman by birth who had never become naturalized. It was an ideal assignment from the Admiralty's viewpoint, but events were to show that their enterprise could make no headway without direct American guidance, despite the engineer's intimate acquaintance with the construction and operation of the old *Holland.* At the time, however, we had agreed that the training of a crew in England could be undertaken without the help of an American personnel.

Preliminary trials were run at Barrow in the port's wet docks, which are huge basins surrounded by stone bulkheads, with a depth of water of about five fathoms. On this part of the English coast the rise and fall of the tide is about thirty feet. At high water these basins were allowed to fill and with the gates closed the depth of five fathoms was maintained. This depth proved sufficient for operating the boats, but the length and breadth of the basins were inadequate, and the commander of the submarine had to guard against colliding with bulkheads. He did not succeed in doing so.

On the first trial run our engineer, who was in command, had a crew of English sailors who had never been in a submarine. They lacked confidence in the work and were more or less skeptical of the outcome of under-water navigation. The boat promptly crashed into a bulkhead while submerged, and arose with a damaged bow and a shaken crew. This experience convinced the builders that more experienced men were needed for the trials.

Hence came a cablegram to New York asking that I be sent to England by the first steamer to undertake them, and I was requested by the company to sail at once.

In my judgment this did not meet the situation. Where was I to get my crew? The answer was, "The English will furnish all the men you need." I told our president that my willingness to run the trials was contingent on taking my own crew. I refused to go under any other conditions. My men had served under me for a number of years and knew the operation of the Holland boats to the last detail. Each was an expert in his own line. I did not propose to go to a strange country and operate submarines, which at best were an unknown quantity, without their efficient co-operation.

The dangers and uncertainties of submarine navigation were not realized by learners. Our early experiments with the *Holland* had taught us that these dangers were manifold and not to be trifled with. An inapt crew of English rookies might readily cause the loss of the boat and their own lives.

The British Admiralty refused to assent to an American crew operating the boat. They wanted only an American instructor—myself.

Exchanges of cablegrams resulted in their yielding, but only after they were persuaded that my decision was final, and they agreed loathfully to let me bring my own crew.

We were in Barrow by the middle of February, 1902. Two of the submarines were in the water, ready for trials. An inspection revealed that, although they had been built according to the original plan, they lacked certain features we had later found essential in American operation. These changes were of vital importance, and I urged that they be made before we attempted any trials. The outlook meant a long delay that discouraged the builders and the Admiralty, as well as the officers in charge of the work. But they agreed to let me have a free hand, and placed the onus on me for the success of the boat's trials after the changes had been made. The Holland Company thus virtually fathered the British boats through my insistence on imperative changes as its representative, and the work was undertaken, lasting twenty-four hours a day for several weeks, including Sundays. By the end of March the first boat was ready for trial.

We endeavored to keep our runs secret, but we found British newspaper men quite as enterprising as their American confrères and more than equal to the dark designs of a reticent Admiralty. Early on the day of our first run the townspeople, informed by the press of our purpose, assembled along our course. Submarines then were as much a curiosity in England as elsewhere. As in the United States, we rarely escaped an interested audience.

Several English members of our crew, which included a number of naval officers assigned to us for instruction, had grave misgivings as to whether we would come to the surface again after submerging. They wanted to know what we would do if the boat became stalled under water. Ought we not to take plenty of food and fresh water to safeguard against such an emergency? Our own men, who were at home in Davy Jones's locker, naturally did not share the discomfort and uncertainty which worried the Englishmen.

It was really an anxious moment for our raw recruits when, on the afternoon of March 31st, our boat slowly sank until only the top of the conning tower was visible. The order I gave for full speed ahead, and then for diving, made them more anxious. The boat slowly took an angle of five degrees and disappeared. Two minutes later we came up for observation. The ordeal was over; they had tasted first blood of Neptune under the waves.

Several more dives followed of two minutes' duration; then up to the surface again with blown-out water ballast and an opened conning tower. Thousands of people crowded the line of our course and greeted us with wild cheering each time we emerged.

When we tied up at the dock for the day after such mild immersions, which extended for an hour and a half, the English members of our crew seemed the happiest men alive. They had once more set foot on dry land and the worst was over.

A few days later came the official trials of the first boat in the Irish Sea, consisting of a four-mile run and quick dives of short duration. In order to open the gates of the Barrow basins, it was necessary to leave for the open sea at high water, which came early in the morning. Accordingly, we left our dock at 5.30 A. M., arriving at our testing range in the Irish Sea an hour later. The trials were carried through as scheduled and we were back again by 9.45 A. M. Thereupon the boat was accepted by the Admiralty and became the first submarine to join the British navy. A like success having been achieved by the second boat, the Admiralty decided that the officers and men who had been under our instruction were competent to handle the boats without further guidance from us.

There is always a heavy ground swell running in the Irish Sea. But we encountered no trouble in maintaining our depth and in steering our course. The depths varied from five feet to thirty-five feet. We steered courses of two and one-half miles without coming to the surface, moving solely by compass, and striking targets 150 feet long at the end of the two and one-half miles in face of the ground swell, which in the Irish Sea is felt much deeper than in other waters. We did not feel the sea; neither a ground swell nor a heavy sea affected our operations. When we submerged we steered a much straighter course than we could with a surface boat, because we had not the wind to contend with; we had only the currents.

We impressed upon the English officers in charge the vital importance of extreme care and vigilance, especially in the rigid closing of every opening, such as ventilators, hatches, and valves before submerging, and in guarding against leaks from the gasoline equipment.

The warning was needed. On my first inspection of the boats after taking charge, I found many gasoline leaks, more or less oil in the bilges, and the atmosphere saturated with gasoline fumes. Yet in spite of this obvious danger of ignition, the English officers and workmen were allowed to smoke in the boats at will.

My order forbidding smoking inside the boat was unwillingly respected while I remained in charge, but after our departure for the United States the British officers returned to their lax methods in controlling the boats. Less than a month later a gasoline explosion in the first boat placed five men in the hospital. This was only one of many similar mishaps which befell British submarines in their early operations. The only evidence found pointing to the cause of the explosion, as far as I know, was the bowl of a clay pipe freshly filled with tobacco. Some workman was apparently about to light his pipe and the match ignited the gasoline fumes.

The Admiralty was henceforth committed to submarine construction, primarily for coast defense, and British naval men assigned to undersea boats duly became reconciled to "potted air" and the inevitable risks conditioning their navigation. The pressure of public opinion, disturbed by our progress, as well as French enterprise, had forced the British authorities, as one press writer commented, "to show some justifications for the faith that is in them, which is really no faith at all." The Holland type at the time had no active competitor beyond the products of ardent French inventors, the construction of whose boats was solely confined to France and guarded by the government.

Officially it was hoped in Great Britain that the submarine would be discredited by the Admiralty experiments. No aspersion was aimed at the Holland type, but rather at the fundamental principle of submarine navigation. Therefore our mission on the Irish Sea trials to prove the worth of Holland's ideas involved also a vindication of the activities of every inventor experimenting in the submarine field.

The wish was father to the thought in the British hope of submarine failure. It had been so from the first. The navy did not want the submarine to be justified. In those days the fear that British naval supremacy would be jeopardized by the submarine, as Holland had long predicted, is an old story; then it was a new terror. Great Britain had staked her all on the battleship, on its capacity to steam through storm and fog, to blockade the enemy in his ports, or to fight him on the high seas. The navy resented any innovation by a new arm that would revolutionize naval tactics. But the submarine had its way.

CHAPTER XVI

Uncle Sam has a submarine fleet at last.—Performances of the *Adder* and *Moccasin*.—Sand-bar dangers.—Testing the *Grampus* and *Pike* in the pitch-dark waters of San Francisco Bay.—The reconditioned *Fulton* and the Lake boat *Protector* have competing trials before a naval board at Newport.—Structural differences of the two types.—Target shooting and a twelve-hour submergence.—Both boats sold to Russia.

A LANDMARK in American submarine development came in the course of 1903, when the *Adder, Moccasin, Porpoise, Shark, Grampus, Pike,* and the reconstructed *Plunger* were delivered to the Navy Department after the customary tests. Uncle Sam's submarine fleet was in being at last. Each boat realized our expectations from the improvements we had devised and incorporated in them after our enlightening experience of the working of their elder sister ship, the *Fulton.*

The *Adder's* trials on the Potomac in the early summer of 1903 were daily events. Each day she made from ten to one hundred submerged runs with her quota of guests, serving as a novel excursion boat for interested Senators, House representatives, and government officials. The submarine was still very much in its infancy, and official Washington more than ever needed careful cultivation.

An early obstacle we had to overcome in operating the *Adder* was her inability to operate in fresh water. Though she had been designed for both fresh and salt water, some error had been made in determining her trim for inshore runs. We found such a variation of calculation had been made by the builders in adapting her to fresh water that we had to remove a portion of our permanent weights aft and make other changes in order to proceed.

Later tests of the *Adder,* as well as of the *Moccasin* on our Long Island ground, enabled us to accumulate a new stock of experience which bore fruit in the more elaborate boats that followed them. One run we made under water, scheduled for three hours without coming to the surface, brought us in contact with sand bars. Our trial course limited our operations to a distance of not more than four or five miles in any direction, and in order to stay submerged for the time required we were obliged to cover twenty-one knots. This entailed a run in one direction, then turning around and running in another direction. Several bars and points of land intervened, which we were liable to hit, for lack of the long-wanted periscope. Up to now we still ran on time and compass only.

I had actually run for two hours and fifty-seven minutes when, by some misreckoning, I struck one of the numerous sand bars. We were in only about three fathoms of water, while on either side of the bar were ten or twelve fathoms. Immediately on hitting the bar I ordered the boat to the surface. With diving rudder hard up, the boat slid over the bar, but the suction of the propeller held the stern on the bottom, causing her to slide into deep water, her nose pointed up.

A prominent naval officer we had with us was frightened, as he could not understand why the boat should be going down when her nose was pointed up, and she had a hard-rising rudder.

We ran in this condition for a few seconds, meanwhile sinking deeper. It was necessary to blow out one of our ballast tanks before we could raise the boat out of the mud. As soon as she started for the surface we refilled the tank, but the conning tower was exposed five seconds before we could disappear to complete our three-hour submerged run. As our performance lacked only three minutes of the scheduled time, the Board of Inspection conceded us a full rating.

Tests with the *Grampus* and *Pike* in San Francisco Bay encountered the usual initial difficulties attending the operation of craft fresh from the shipyard. In addition we were handicapped by strong tides, which imperilled our marker buoys, and mud made the water impenetrable and dark as night. On the Atlantic coast daylight penetrated our deadlights to a depth of five fathoms. In San Francisco Bay the daylight ended a foot beneath the surface.

The trials were a successful repetition of those conducted on the east coast, barring the loss of a torpedo, but were hampered by the presence of a large number of transports anchored at one end of the course and shoal water at the other. Minute calculations of speed and the strength of the tide were needful to avert colliding with the transports or stranding among the shoals.

Our attention was next directed to reconditioning the *Fulton,* which, as before recounted, had been disabled by a battery explosion. We had sold her to Russia, but our primary object in putting her into shipshape was to fit her for rigid tests to meet the requirements for building further submarines with a new appropriation for $1,000,000 Congress had made. The boats were to be of American design and construction, and the best in the field. Only two craft were available for the test, our *Fulton* and the *Protector,* the latter built by Simon Lake. Like the *Fulton,* the *Protector* had been purchased by Russia. Hence, neither boat was destined for our navy and could only be utilized as working craft to demonstrate the future product of competing builders.

The Lake boat, designed for war purposes, had been evolved from the inventor's early Argonaut type earlier mentioned, which was intended solely for the peaceful purpose of locating wrecks. The craft now developed was 70 feet long over all, 11 feet wide, and had a submerged displacement of 170 tons. She had gasoline engines actuated by twin screws, as against the single screw of the *Fulton.* Her steaming radius on the surface was 1,500 miles, her surface speed 11 knots, and her submerged speed 7 knots. Her air tubes were charged at a pressure of 2,000 pounds, capable of supplying sufficient air to enable a crew of six men to remain submerged for 60 hours. She had three eighteen-inch torpedo tubes, one on each side of the bow and one in the stern.

Her inventor's method of operation departed widely from ours. There were three methods of submerging the Lake type—either by admitting water ballast and so destroying the buoyancy, or by the use of hydroplanes, or by dropping two heavy anchors, which were lowered by wire cables. The hydroplanes were so placed amidships that their downward tendency, which overcame the boat's buoyancy when she moved ahead, was balanced, enabling the vessel to descend with her longitudinal axis parallel with the water surface. The heavy anchors were dropped till they reached the sea bed, and, the boat's buoyancy being sufficiently decreased, it could be pulled down to the anchors by suitable mechanism. Thus the boat could be anchored at any desired depth within range of her capacity. In raising her the anchors were hauled in, and sufficient water was discharged from the ballast tanks by means of compressed air or pumps. The anchors could be cast adrift, as well as a large section of the boat's keel, in case of accident under water, and the lightened boat could thus come to the surface.

The Lake boat's fuel was not stored in the hull, as in the Holland type, but in a superstructure built on the top of the hull proper.

This method of storing the oil overhead was adopted because of the great danger—as we found—in having the tanks inside the main structure, where the gasoline, being a very volatile fluid, readily gave off a highly inflammable gas. But as gasoline was absolutely necessary in the boat while oil engines provided the means of propulsion, the danger of ignition could not be wholly removed, no matter where the fuel was stored. A tank always secure from leakage of fumes was not impossible, but difficult of realization. Carrying the gasoline outside the hull certainly reduced somewhat one element of danger in submarine navigation, but the arrangement did not contribute to the Lake type's success in navy tests with a later boat.

The sea bed could be explored by divers, who had means of entering or leaving the vessel while submerged by a door opening through the bottom in a separate compartment forward. Compressed air prevented the water from entering the compartment when this door was opened for the diver's egress and return. Captain Lake in this type made the sea bed his objective. He held that traveling along it was the best method of progression in a submarine. Underneath the boat a couple of wheels projected, some three feet in diameter, mounted on short arms. When not in use they could be housed in trunks, like the sliding reels and centerboards of sailing craft. The wheels were placed on the fore-and-aft line, one in front of the other, so that the boat proceeded as a bicycle, being almost buoyant. Little weight burdened the wheels, and the boat maintained an upright position.

The *Protector* was ready for the fray. We had looked forward to having competitive tests between her and the *Fulton* on Narragansett Bay in the summer of 1903, but our boat was not ready to compete before the spring of the following year. The *Protector* underwent her test alone before a naval board, and was later shipped to Russia, whither the *Fulton* was bound after a similar trial. Neither test was fruitful of results, despite official approval of the *Fulton's* performance. A more productive contest between the Lake and the Holland types for the $1,000,000 appropriation was to come later.

The *Fulton's* trials at Newport before the Board of Inspection and Survey lasted several days. Their main feature was a difficult torpedo attack. We had a target fixed by means of two small boats anchored three hundred feet apart to represent the length of a small warship, and toward it we were to start at a distance of ten miles, running submerged the entire distance, and using only our periscope (the periscope had arrived at last) for observation. The efficiency of the run was determined by the infrequency with which we exposed our periscope. The two boats lay about a mile eastward of Block Island, while our starting point of submergence was near Brenton's Reef. We had to take our course from the chart and ran the risk of error in direction through an inaccurate compass. There was a considerable sea, which impeded our making swift observations through the periscope in the briefest possible time required.

Running on time and compass only, a small flag on a signal mast showing above water to indicate our movements to observers, we covered about five miles before making our first observation, when the periscope was exposed only for a few seconds. The heavy sea obscured our target. After another three miles we made a second observation, but still failed to pick up the target. Nearer by another mile, we at last sighted the target, with our course off about twenty-five yards. We corrected our course and submerged for the last time.

Owing to the heavy sea and the danger of losing our torpedo had we fired one, the board allowed us to run between the two small boats which indicated the location of our target, assuming that, had we fired the torpedo, we would have hit it. We actually had gone through the target by about half a mile. A photograph taken of our signal flag as we passed through showed the *Fulton* in the center of the distance between the two small boats.

In a second trial we were supposed to have had our periscope shot away, obliging us to make for the target without this instrument. To do so we came to the surface, went back five miles, and again submerged, headed for the target. The only method of observation now was by coming to the surface and looking out through our conning tower deadlights. On this run we rose to the surface twice, exposing our conning tower for only a few seconds, and struck the target almost at the same point as in the first run. This trial was pronounced successful.

Finally we submerged the boat with a full crew for twelve hours to demonstrate that men could live in a submarine for a long period without inconvenience. We had done it before, but this matter of existing under water was always uppermost as a desired proof of successful submarine navigation. A naval officer we had with us, representing the Board of Inspection, said before we submerged that he was very fussy about the air in his sleeping apartment at night, and usually kept one of his windows open. We suggested that he refrain from insisting on this requirement, as we did not recommend open windows while submerged in a submarine. He had an excellent night's rest, enduring confinement from 8:30 P. M. to 8:30 A. M. without ill effects, like the rest of us. We did not change the air in the boat until we had been down eleven and one-half hours, and our only reason for doing so at all was to demonstrate our facilities for revitalizing the air whenever necessary.

The *Fulton* was then prepared for shipment to Russia, an operation by no means simple in view of the enforcement of our neutrality laws in the Russo-Japanese War, which was then raging.

CHAPTER XVII

Smuggling the *Fulton* to Kronstadt to elude American neutrality laws, owing to Russo-Japanese War.—Cargo camouflaged in clearance papers.—Towing out the *Fulton* in the night without lights to a waiting freighter off Montauk Point.—A destroyer appears and vanishes.—Stealthy work of shipping the boat in inky darkness by a floating derrick.—Customs officials discover they have cleared a contraband cargo.—The *Fulton* becomes the *Madam*.—My movements are watched in following her to Kronstadt to instruct Russian crew.—Preparing the Rodjesvensky fleet delays trials.—The *Madam's* 100-mile run to trial ground in the Gulf of Finland.—Floating workshop comes to grief.—Isolated Bjorka.—Russian satisfaction with tests.—Dismantling the *Madam* for journey to Vladivostok.—Awaits the appearance of the Tsar to inspect her.—The Tsar considers the convenience of an American citizen.—The *Madam* on patrol duty at Vladivostok.

The Lake boat *Protector* had already been dispatched to Russia, and press comment thereon, in view of American neutrality, made us dubious of similar success in delivering the *Fulton* overseas as an ordinary shipment. We did not desire public strictures on our action, nor did we intend that Russia should be deprived of the boat (which was hers subject to the usual tests) because of the war. Our first plan was to place her openly on the deck of a tramp steamer for transport direct to Kronstadt, but we decided not to take the risk. The only chance of getting the boat abroad was to smuggle her out of the country, and that involved an equal risk of her confiscation as contraband if any naval prowler discovered us.

The *Fulton* was back at our New Suffolk proving station on Long Island Sound. A few miles off Montauk Point lay a vessel we had chartered, which had proceeded there from Newport News, where she had loaded coal for ballast. Another craft we requisitioned, a floating derrick from New York, was stationed at a point on the Sound abreast of Long Island.

An initial difficulty to surmount was obtaining clearance papers. It was necessary to get them from the nearest point of departure (in this case Sag Harbor), and, for our purpose, before the vessel was actually loaded. We did not want to deposit our submarine on her deck, and then, should the customs official's suspicions be aroused, have our clearance papers refused.

On June 28th our own tender steamed out from New Suffolk to Montauk Point, took off the steamer's captain, and conveyed him to the customhouse at Sag Harbor. His was probably the first vessel which had applied for clearance papers from that port in thirty years. The customs official there could not readily produce the needful blanks, and he was not quite sure just how to fill them out when he found them. The difficulty was duly overcome, the cargo successfully camouflaged, and the clearance papers obtained.

The stage was now set for delivering the goods. The skipper returned to his ship with orders to proceed at eleven o'clock that night to a point about the middle of Gardiners Bay. The captain of the derrick craft received like instructions. At our proving station, about twelve miles distant, everything was in readiness for towing the *Fulton* out to the ship. Our movements were covered. No one in the town knew that anything unusual was afoot. Our crew had been sworn to secrecy and told nothing.

At the usual time of retiring for the night all hands turned in, but not to sleep. At ten o'clock they turned out again in the dark. No lights, either in their homes or outside, disclosed their movements. Our tugboat lay alongside the *Fulton,* not a light showing. At eleven o'clock the lines were made fast to the *Fulton,* and slowly and quietly the tender pulled out of her berth and got under way. At

RUSSIAN SUBMARINE TAKEN IN THE GULF OF FINLAND, 1904

LOADING "FULTON" ON TRAMP STEAMER FOR SHIPMENT TO RUSSIA, 1904

about twelve-thirty we were in Gardiners Bay.

We had some trouble in locating the waiting steamer and lighter in the dark waters, as they, too, had no lights. Blind maneuvering finally landed the *Fulton* alongside the derrick, and the task of slinging her began. The operation required hours of hard labor in the dark, only an occasional lantern, used when absolutely necessary, betraying our presence. What seemed to be flame erupting from the funnels of a destroyer lit the darkness some miles distant, the craft evidently headed in our direction. We feared our lantern had exposed our nefarious operations, and instantly came visions of heavy fines and imprisonment. But we had eluded naval sleuths before, and we did so now. The destroyer disappeared and welcome darkness shielded us again.

It was 3:30 A. M. before the *Fulton* could be lifted. The creaking chains and the purring of the motors operating the derrick broke the stillness and scared us by their noise. Every man held his breath. Slowly the submarine, a weight of eighty tons, left the water and hung suspended in midair. In ten minutes she was swung over the deck of the outgoing ship and lowered into cradles previously prepared. There she was fastened down and swathed in canvas to guard against discovery from prying eyes should the ship chance to be accosted by other craft *en route.*

We headed out to sea beyond the three-mile limit, where safety lay, and I returned ashore by our tender, which had been escorting the steamer out. Two members of the crew remained on board to overlook the *Fulton* and her unloading at destination.

She was four days out, well beyond hearing, before the suspicion dawned on the customs officials at Sag Harbor that they had cleared a contraband cargo. But this was not the whole story. In preparing the submarine for shipment we had to reduce her weight by removing the storage battery, and this equipment we succeeded in disguising by boxing up and shipping on another steamer.

The voyage was, fortunately, without incident. The captain had sealed orders which instructed him to stop at Reval. There further instructions awaited him, telling him to land at Kronstadt and unload. Some ten days after leaving Montauk Point the *Fulton* was dropped into that Russian harbor and towed to Petrograd.

Thereafter the Fulton was no more. In fact, she ceased to exist immediately after leaving

American waters. She became the *Madam* until she entered the service of the Russian navy.

Later, with a special crew, I followed the *Madam* to Petrograd. Our commission was to put her in operation, run trials, and train a Russian crew to handle her. The vessel I sailed on, the *Kronprinz,* did not contain my name on her passenger list. It was a small matter, but we desired to forestall any questions that might arise regarding our rendering assistance to the Russian government in time of war, and so my departure was veiled in secrecy, like the *Fulton's*.

On board I found myself under the surveillance of a strange passenger. The nature of my mission would make any one suspicious of being shadowed, and I watched him as much as he did me. When the vessel stopped to land passengers at Cherbourg, my observer was evidently prepared to leave the ship if I did, but, as I did not, he also remained.

We landed at Bremerhaven on August 2d, stayed the night at Bremen, and went on to Berlin the next day. The man who watched me was always near. I was unable to escape him even while sight-seeing on the Unter-den-Linden. He disappeared the next morning, when we entrained for Petrograd. Either his trail of me had grown cold or he decided that my mission in Europe was not that he suspected.

The *Madam* awaited us at the Nevsky Dockyard. One of the first persons I met there was Baron Fersen, lately an attaché of the Russian Embassy in the United States, who had made several runs in the *Madam* in American waters. He was to command a new cruiser then being finished by the Nevsky Yard for Admiral Rodjesvensky's Baltic fleet. He spoke hopefully of the work in store for him in the Far East, but I understand that in the battle of the Sea of Japan his cruiser fled and was later beached on the Island of Sakhalin and blown up.

Just now the entire Russian navy was absorbed in preparing the Rodjesvensky fleet for its ill-fated expedition, and for this reason the Navy Department, although in great need of the *Madam,* could not give us the necessary facilities to put her through her official trials.

In our preliminary work we were impeded by lack of needed material. We could get little co-operation from the Russian workmen, contact with whom was further handicapped by the barrier of language, though this obstacle was overcome by an interpreter.

LAUNCHING SUBMARINE IN RUSSIA, 1904

The *Madam* was duly ready for trials, and then we searched for a suitable course, which we found in a small bay close to Petrograd. This water served for preliminary runs, but was not suited for official trials. Naval preoccupation with the Baltic fleet delayed these until early in October. Then we were notified that the trials would take place in the Gulf of Finland, about one hundred miles from Petrograd, near the little Finnish town of Bjorkö, where we were to make our headquarters.

We did not depend on what accommodations the town might have available for us. A small steamer was chartered to house our own crew and tend the *Madam* during her trials. We also purchased a small canal boat and fitted her up as a workshop and storehouse. This boat carried all our supplies and provided quarters for our Russian crew.

In moving out from Petrograd for our trial grounds the steamer towed the canal boat, while the *Madam* made the run under her own power. It was a day journey, begun before dawn in perfect weather. The afternoon brought a high wind and heavy sea. We noticed that our canal boat in tow of the steamer was making bad weather, and that the men on her were constantly at the pumps, indicating that she was leaking badly. However, it survived the journey to Bjorkö, where we dropped anchor. Shortly after dark we tied up in a good harbor. During the night I was reminded of our leaking boat by the watch, who called me and warned that she could not keep afloat. All hands thereupon turned out, and what we could save of our supplies (of which we had many) was transferred to the steamer. The boat was then towed across the harbor and beached. This was the last of our little workshop.

Daylight the next morning revealed a Russian cruiser a short distance from us and alongside her the Lake submarine *Protector,* which was also there for trials.

We found Bjorkö a town isolated from the world. The nearest railroad station was thirty miles and there were only two mails a week. Besides a post and telegraph office, it had a few primitive houses and a church. The people were glad to mingle with Americans. Though only a hundred miles from Petrograd, they could not understand a word of Russian. Only Finnish was spoken, but fortunately for us our interpreter knew both tongues. As it was Sunday, all hands attended church, as was customary on the first Sabbath we spent in a strange place, but none of us were qualified to pass upon the quality of the sermon, and the interpreter was not consulted on this point.

The Holland boats had long since passed the stage when decisive official trials involved a risk of failure to demonstrate their capacities. These Russian tests, conducted on October 12th, consisted of a surface run of a mile, a submerged run of the same distance, and the firing of a torpedo. They presented no difficulty and were pronounced successful. The torpedo trial was particularly gratifying to our naval judges, though the projectile promptly lost itself and was not found until several months later. The training of the Russian crew, which embraced two officers and eight men, occupied another ten days, by which time they decided they had received sufficient instruction and we brought the *Madam* back to Petrograd.

Our allotted part in turning over the boat was finished, but further aid was sought from us to transport her to Vladivostok by rail. Her conning tower had to be removed to afford safe passage through tunnels and bridges of the Siberian Railroad. Hence I remained to see that the boat was properly stowed on a freight car for her long overland trip over the Tsar's dominions. By a flattering offer the government tried to induce me to accompany the *Madam,* but as the war with Japan was then at its height, and Vladivostok a center of hostilities, I decided that New York City was safer.

I was, in fact, eager to leave Russia, and requested that the boat be prepared for shipment promptly. It was a land of delays. The Tsar desired to inspect the boat before she was dismantled and the work was deferred pending his appearance. After waiting patiently for several days, I informed the Russian officials that I had arranged to leave Petrograd on October 29th, and could let nothing interfere with my program. The same afternoon the Tsar came and inspected the boat, and I had the privilege of meeting him. The Tsar of all the Russias had considered the convenience of an American citizen.

The *Madam* was dismantled and sent on her journey to Vladivostok, where she was reassembled and went on patrol duty outside that port. Her officers were bent on sinking any Japanese craft in sight, but there is no record that they succeeded in doing so. The boat remained out on patrol several days at a time, only returning to port at intervals for supplies. On one occasion, while entering the harbor, she was mistaken for a Japanese torpedo boat by the fort gunners, who opened fire on her. None of the shots took effect. She immediately submerged, staying on the bottom until night, and entered under the cover of darkness. After the war with Japan nothing more was heard of the *Madam*.

CHAPTER XVIII

Development of submarine-boat equipment.—Need of bigger engines.—A stolen inspection of German submarines at Kiel.—Germany's tardy adoption of submersibles influenced by British action.—Growth of Holland type in Europe.—Search for the perfect periscope.—Italy's submarines.—The *Squalo,* with watertight compartments, continues to run submerged with a ton of water in her engine room.—A French gasoline engine for submerged operation.—France's submarines.—Identical with Holland's in general principles.—Submarine building for American navy retarded by government indecision.—Holland boats for Japan.

Submarine development had inspired European technicians to exercise their ingenuity in contriving improved engines, periscopes, and other mechanical devices. We needed the best equipment in sight, and it was part of my mission abroad to examine their product.

Up to this time the largest engine used was of 160 h. p. and of the gasoline type. The submarine's immediate future called for the development of engines of greater capacity than that. For several months we had been studying the field without finding any efficient engines larger than those we were using. We had been in communication with a Russian inventor, named Loutski, who had designed two engines with a capacity of 300 h. p. each, which were being built at Kiel. I visited Kiel, primarily to inspect these engines, but I was also anxious to see some of the German submarines then under construction there.

In order to reach the plant where the engines were, I crossed the harbor in a motor launch and observed several of the submarines in the water under military guard. I ordered the launch to run alongside one of the boats to get a close view of the hull. A German soldier evidently tried to tell me that no one was allowed near the boat, but as I did not know German, he made me understand his meaning by the use of his gun. My presence was not wanted. His demonstration was perfectly clear, but before retreating I succeeded in making a careful scrutiny of the submarine which in later years was to fill the world with fear and trembling.

Germany had looked on indifferently at the development of submersibles, but the attention bestowed on them by the United States, France, and Great Britain finally forced her to change her view. Admiral von Tirpitz, her naval chief, for long held an unfavorable opinion of undersea navigation, and had announced that the German navy would not initiate the construction of any submarines. The attitude of

Austria was as hostile, to judge by an authentic deliverance made by a naval officer at the Austrial Military Casino in 1901, when he contended that so far there was little prospect of the submarine playing an important part in naval warfare, and, anyway, Austria-Hungary preferred to await results of further experiments before adopting such vessels.

Probably it was Great Britain's acceptance of the Holland type that hastened Germany's change of front. Any new device adopted by the British Admiralty instantly became, by the very nature of Anglo-German relations, a matter of importance to Germany's naval policy. Yet the British naval lords, as I have before indicated, were hardly serious about their venture. They ordered Holland boats without even seeing the type, only knowing of it by description, and their requirements were much less exacting than those of our own Navy Department. They did not look for great speed, nor even accuracy regarding the firing of the torpedo. All they wanted was to see the boat operate under water and to be assured that she could be handled by a British crew.

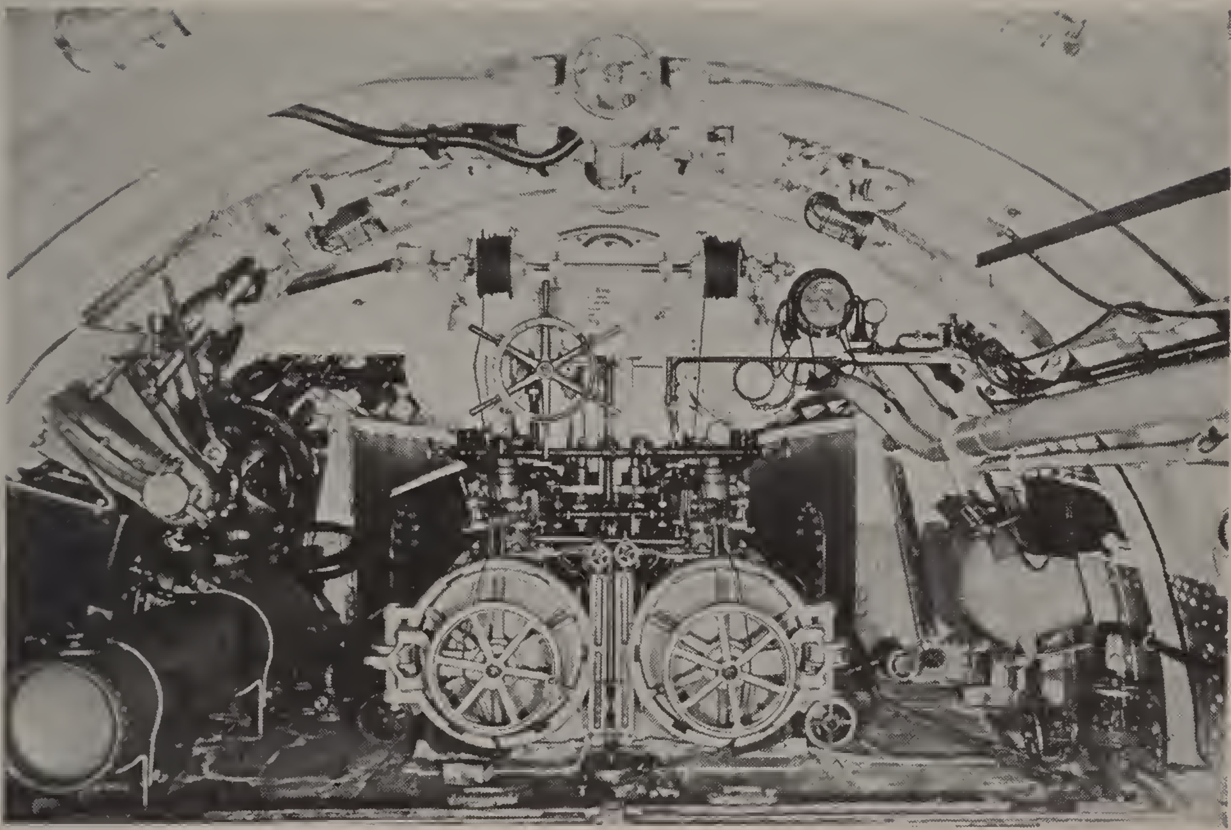
The success of the Holland boats produced by their British contractors led to an extension of licenses to build the type among European firms in order to save expense and the risk of transportation involved in constructing them in America. Thus in Germany the boats came to be constructed by the Deutsche Parsons Turbinia Company, then by Krupps; in Austria by the Whitehead Company; in Holland by "De Schelde"; and in Russia by the Nevsky Works, in addition to Vickers Sons & Maxim, in England. In some cases our designs were closely followed under the supervision of American engineers. In others modifications were introduced by the licensees working in co-operation with the admiralties of the respective nations for whom the boats were being built.

Holland himself always held that alone of all the countries who adopted his submarine, Germany and Japan built boats that represented his mature conceptions. Certainly Germany's submarine record in the World War told its own story of the efficiency of her U-boats, not only as destructive weapons, but in the great navigating radius they could undertake without emerging to the surface.

A search for the perfect periscope took me from Germany to Florence, where I examined the products of one of the largest optical companies in Italy. We had adopted periscopes, but the device was still in its infancy and more or less crude. Though a number of concerns were attempting to make them, the day had not yet come for the perfected type used so tragically in the World War.

Italy was unobtrusively experimenting with her first submarine, the *Delfino,* built in 1889. Originally this boat had a speed of five knots on the surface, and only two knots submerged. To enable her to sink on an even keel, and, in fact, control her submergence, she was fitted with a couple of propellers set in vertical tubes running through the boat, something after the plan adopted by Nordenfeldt in a boat he built for Russia before that country adopted the Holland type. Among further changes she was also fitted with a superstructure resembling that later installed on the American and British Hollands. The result was an increased surface speed to eight knots and more than six knots under water.

The new *Delfino* became the groundwork for enlarged boats of the *Glauco* type, built by Cesare Laurenti, which took a creditable part in the Italian naval maneuvers of 1906. They ran from Venice to Taranto without convoy under their own power, submerging to depths



INTERIOR OF SUBMARINE, LOOKING FORWARD

SUBMARINE RUNNING FULL SPEED SUBMERGED. TWO PERISCOPES SHOWING

of from thirty-six to sixty-six feet and attacked anchored vessels guarded by a large flotilla of torpedo craft.

Their interior was distinctive in being divided into eight separate water-tight compartments, so that the engine room would be hermetically sealed and cut off from the remaining divisions, thus preventing heat and gases permeating to other parts of the boat when submerged. The subdivisioning proved a decisive element of safety for one of the boats, the *Squalo,* during the maneuvers. She continued to run submerged despite a ton of water in her engine room, acquired through a defective valve of the water jacket of the motors. Our own *Shark* lost her reserve bouyancy on one occasion because of a break in her engine exhaust valve and narrowly escaped sinking. Only a few pounds of water had seeped into the vessel, yet it was enough to imperil her. The Italians were also forward in developing the even-keel method of submersion after a brief preparation in trimming from the surface condition. Our boats submerged on the diving principle at this time at an angle of five degrees until the desired depth was reached, but great care and skill had to be exercised by the operator at the horizontal rudder. Apparently the Italian boats ran submerged with a change of longitudinal trim of not more than one to two degrees at the most. The developed Italian craft in the World War period acquitted themselves well in patrol work and in their attacks on Austrian naval vessels.

A French inventor's design of a gasoline engine of the closed cycle type, intended to operate in a submarine while submerged, next drew me to Paris as part of my itinerary. I was skeptical of his success. Our only method of propelling boats under water was by storage battery and electric motor. It was impossible to operate gasoline engines below the surface, owing to lack of air for combustion. The Frenchman claimed to have overcome this, and we had taken the risk of ordering two of his engines, which were then being constructed in a suburb of Paris. I spent several days examining them. Like numerous other inventions, they proved a failure. No one has yet been able to operate an engine of this type undersea without a suitable amount of air, which cannot be obtained in a submerged submarine.

Little was revealed of the status of French submarines and the extent to which the Ministry of Marine was experimenting with new devices. The government had successfully drawn a veil of secrecy over what they had done with their boats. Even our own Bureau of Steam Engineering, which was reputed to be better informed regarding developments in foreign navies, lacked knowledge of French plans and practice. Probably the British Admiralty knew less. France's naval program, however, showed that she was looking farther ahead than the United States and Great Britain. It authorized the building of forty-four submarines between 1900 and 1905, and enlarged this list to sixty-eight boats for completion before 1906. At first they were not intended to have a great navigating radius, their purpose being rather to defend seaports, whither they could be transported or towed. In contrast with Great Britain's submarine fleet of ten boats, which she had in 1903, and the seven boats possessed by the United States, France's enterprise at this period made her the most advanced nation in the world in submarine construction.

Underwater navigation had seized the French imagination. Two boats constructed for the navy were actually paid for by popular subscription through the stimulating enterprise of the Paris *Matin*. As the people presented the nation with these boats, it was caustically assumed that the Admiralty was forced to proceed with a submarine program through public pressure. "No evidence can be found," wrote Admiral Melville (United States), who disbelieved in the submarine, "that a popular subscription was needed to build either a battleship, armored cruiser, protected cruiser, or torpedo boat; in the construction of these practical fighting machines, the French Admiralty officials required no spurring from the general populace . . . that must of necessity be unacquainted with the essential features of an innovation in naval construction."

The most notable of the French submarines of the time was Laubeuf's *Marvel,* launched in 1899, whose hull had double skins, the intervening spaces being entirely water-filled when the craft submerged. Though independently worked out, the designs of French inventors were identical with Holland's as to general principles, and approached each other in main features, as Lieutenant Lawrence Y. Spear pointed out, allowing, of course, for the different aims of the designers. At the time of my visit (1904) France sought boats that should be both defensive and offensive, and developed them in displacement, adopting great length in proportion to beam with double hull and large tank capacity. Her possible enemy was within easy striking distance, and offered vulnerable points in the form of large ports and arsenals. It is to be noted, however, that, despite France's progressiveness in submarine construction, she found little use for her boats when the great test came in the World War.

After a flying visit to the Netherlands to inspect a Holland boat under construction for the Dutch government at Vlissingen, I realized that I had been absent from the United States for several months. I wondered how the submarine situation was faring at home in view of the government contract of $1,000,000, the award of which was pending when I left. Assuming that it had already been given to the only plant— our own— which had so far met our navy's requirements, I was eager to return and take further part in the work to which I was devoted. On returning, however, I found that the government had not made any award, and there was no immediate prospect of our building further submarines for the navy.

The only work that occupied the Holland plant, at New Suffolk, was the building of five boats for Japan. These craft were of the *Adder* class; and had been temporarily erected, then dismantled and shipped for completion in a Japanese navy yard. Meantime our large corps of experts, for lack of government orders, continued their development work, undeterred by discouragement. We all believed in the successful outcome of our aims, and though our financial condition might be low our enthusiasm ran high.

It was my lot to be withdrawn again from taking part in the development work. Early in 1905 I was assigned to proceed to Japan to supervise the completion of the boats we had shipped there, conduct trials, and train a Japanese crew to handle them.

CHAPTER XIX

A Pacific journey to Japan under war conditions—Contraband on liner.—At Midway Island.—Fear of the Russian fleet.—Yokohama.—Holland submarines at Yokosuka dockyard.—Japanese hospitality.—Navy eager for submarine operations off Vladivostok.—Expeditious preparations and trials of boats.—No lost motion.—Peace balks submarine enthusiasts.—Japanese naval officers quick to learn and faithfully follow instructions.—Loss of a Holland boat with all hands.—Dead commander's story of tragedy found in the conning tower on raising of craft.—A naval banquet in honor of the American submarine experts who taught the Japanese undersea navigation.

THE Russo-Japanese conflict approached its crest when I sailed from San Francisco on the Pacific Mail liner *Manchuria* for Yokohama *via* Honolulu in the middle of April, 1905. The vessel was laden with war munitions, and the appearance of myself and associates among her passengers had drawn spacious comments from the San Francisco papers more than hinting that our mission to Japan violated American neutrality. We abated suspicions by stopping off at Honolulu, apparently as tourists in search of diversion. The captain, in view of his war cargo, did not dare to enter the harbor, and a tender took us ashore. We waited quietly at Honolulu for the next vessel eastward, thereby throwing the alert newsmen off the scent.

The *Korea* of the same line duly entered the harbor bound for the Far East, and we continued our journey on her. We suspected that this ship was also loaded with the contraband of war. At any rate, the owners were in some trepidation regarding the movements of the Russian fleet, which had left the Baltic on its circuitous trip to the Orient, several months before, and they were taking precautions against capture. The captain (a young Englishman experiencing his first command of a large passenger ship) had orders to stop at the island of Midway, about 1,200 miles from Honolulu, where a cable station is located. There he was to receive instructions either to proceed or to return to Honolulu.

If the Russian fleet had reached a latitude near enough to endanger his ship, there was no doubt of his course. The prospect of fleeing back to Hawaiian waters with a Russian warship in pursuit was not a pleasant one for many of the passengers.

The night before we reached Midway Island there was a perceptible slowing down of the engines. The captain informed us in explanation that had he maintained full speed during the night he would arrive at the island before daybreak, and as Midway had no lights and was only eight feet above water, he did not want to run over it without knowing it. Soon after daylight we sighted the island, and the vessel anchored outside.

The people of the island were always hungry for news and reading matter, regardless of its nature or age. A launch sent ashore for orders was accordingly laden with piles of discarded newspapers and magazines, which the passengers collected, so that the craft resembled a portable newsstand. Their isle being off the regular route of steamers, the people had no communication with the outside world, except by cable, for months at a time. When we were there the inhabitants numbered only thirty men and one woman, with a few sheep.

The orders received by the captain were to go ahead. The whereabouts of the Russian fleet had not been determined, and the owners were willing to run the risk of landing the ship's cargo in Japan.

When near the 180th meridian an argument arose at breakfast among the passengers as to when we would cross it. An elderly lady asked the captain how we would know. He told her that if she observed closely she would be aware of a slight jar to the ship at about 8.30 that morning. That would mean we were crossing the meridian. The lady's curiosity was satisfied, but whether she felt this jar we never knew.

The meridian was crossed on a Saturday, and Sunday was therefore dropped. We had on board a large number of missionaries who strongly objected to losing a Sabbath. Why not lose some other day? The captain had to assure them that this disposal of Sunday could not be avoided and they must make the best of the deprivation. On the meridian the days had to take their chance. It was a question of first come, first served, and Sunday happened to be the first comer.

About two days before we reached Yokohama we were in waters where there appeared some danger of encountering the Russian fleet. The captain forbade all lights at night; there were no running lights nor deck lights, and the portholes of every cabin were carefully covered. Passengers were anxious to know what the captain would do if a warship appeared in the offing. He told them that he would give it a clean pair of heels and that any pursuer would need a speed of better than twenty knots in order to overtake him. Compared with the ordeals many liners underwent during the World War our situation, the dangers of which turned out to be wholly imaginary, was trivial to the last degree, but we were living in days when the prospect of wholesale destruction of mercantile craft was unthinkable.

Frightened passengers spent the last night on deck before we reached Yokohama. They were sure we would meet the Russian fleet. If the captain attempted to escape we would surely be shot up and sunk. The Russian fleet at the time was really several hundred miles away. A few days later came the battle of the Sea of Japan and the Tsar's feared squadrons were no more.

We came within sight of Yokohama on May 30th. Cape King, at the end of the long peninsula that shelters the enchanting Yeddo Bay, showed through a line of purple cliffs; then rose terraced hills, green with rice and wheat, and, later in the season, golden with grain or stubble. Fleets of square-rigged fishing boats drifted by, their crews clad in the loose, flapping gowns and blue cotton head towels worn by Japanese coolies.

At night Cape King's welcome beacon was succeeded by Hanonsaki's lantern; across the bay shone Sagami's bright light, then sparkled the myriad of flashes from the Yokosuka dock (our submarine headquarters), and last, the red ball of the lightship glowed, marking the edge of the shoal, a mile outside the bund, or sea wall, of Yokohama. The lightship runs up its signal flag if there is a United States man-of-war in the harbor, and two guns are fired as a signal that the American mail has arrived.

Yokohama disappoints the traveler after the splendid panorama of Yeddo Bay. The bund, or sea wall, with its clubhouses, hotels, and residence frontings, is not Oriental enough to be picturesque. As one of our prominent writers has said, "It is too European to be Japanese, and too Japanese to be European."

The waterfront is a creditable contrast to some of our untidy American docks. There were fleets of freighters and war vessels, ugly pink and red canal steamers, brigs and other sailing vessels, but these craft were far outnumbered by the schools of sampans that instantly surround arriving mail ships. Steam launches serve as mail wagons and hotel omnibuses. They puff and whistle at the gangway before the buoy is reached, and boatmen keep up a steady whiz-whiz to the stroke of their crooked, wabbling oars as they scull in and out.

The Yokosuka Dockyard, where our submarines were under construction, is about twenty miles from Yokohama and one of the most important of Japan's naval stations. The boats were well under way when we arrived there, and were being rushed to completion by night and day shifts. Having a war on their hands, the Japanese were anxious to put the boats in action.

An acquaintance with the Japanese officers assigned to the boats was an agreeable experience. Their chief desire was to entertain us. We had to impress on them that we were there for business, not for pleasure, but we could not resist the pressure of the hospitable commander, who invited us to take tea with him and his staff at a small teahouse near the yard. This was our introduction to Japanese customs. Incidentally, we had been warned that to be successful in Nipponese society one's stockings must always be without holes. This proved to be timely information in view of the social obligation imposed on us of removing our shoes at various functions we later attended.

We obtained living quarters at a small hotel in the old town of Kamakura, some miles distant from Yokosuka, which lacked accommodations suitable for Americans. The Kamakura hotel was conducted by Japanese on European methods during the summer. Its staff was entirely composed of girls, and in all our travels we had never found more efficient attendants. It is true that their ways were not our ways. In fact, it took us some time to become accustomed to their habits. Japanese ideas of modesty differ widely from American standards, but we duly surmounted the difficulty and adjusted our viewpoint to the customs of the country.

The Battle of the Sea of Japan had just been fought and won, but the disappearance of Rodjestvensky's fleet had not depleted Russia of war vessels. The Japanese saw immediate work for at least two submarines off Vladivostok, and were eager to have the boats ready for transport to the harbor there.

Toward the close of June we made a surface run in Tokio Bay with one of these boats, which thus became the first submarine operated in the Japanese navy. When a submerged run was later made we had a full crew of Japanese naval officers in addition to our own crew of six men. These officers were to be trained to operate the boat in actual service.

The boat was ready for official trials with its native crew by July 22d and I so notified the commandant of the navy yard. Unlike our experience with the Russian Navy Department, to say nothing of our own, there was no delay. In war Japan's watchword was dispatch. My advice was sent on a Saturday afternoon, and that evening official word came from the commandant that the board of inspection had been appointed and the trials would begin the next morning. I demurred to running trials on a Sunday, and we agreed to hold them the following day.

The trials occupied two days and fulfilled requirements. The board of inspection immediately left for Tokio, and the following morning reported to me that the boat was accepted. When could she be delivered? At once, was my answer. The craft was ready except for checking up certain spare parts. In less than two hours all material had been delivered, the boat's flag hoisted, and lines cast off, and she put out to sea in commission, with a full Japanese crew and no Americans.

The speed with which trials and delivery had been carried out, contrasted with the dilatory naval procedure we had encountered in the United States, deeply impressed us. There was no red tape and no lost motion. The Japanese wanted the boats and they dispensed with wasting time dallying over technical details which would not improve their efficiency. In our varied experience of preparing submarines for operation the world over we had found most governments disposed to attach an undue importance to small requirements, which at times were more apt to impair than help a boat's performance, and only entailed needless delay and expense.

The Japanese stayed at sea four days, during which they navigated the boat several hundred miles under her own power and without convoy. On returning they hitched her at the end of a tow line attached to a steam vessel and were off again. They spent several days thus trying out her towing qualities. Once more returning, they placed torpedoes aboard and all supplies necessary for a long cruise. This time she was to be on the warpath—and then peace was declared.

A more disappointed group of men I never beheld. They had planned to take the boat to Vladivostok and clean up the Russian ships there, and that, no doubt, they would readily have achieved had the war lasted another two weeks.

The Japanese people did not want peace, and resented the active share the Americans had taken in ending hostilities. In Yokohama, where I had occasion to spend some days, I found the relations between Japanese and Americans much strained from this cause. One morning I woke to find the city under martial law. During the night a mob had burned several American churches, and troops were called from Tokio. Street corners were held by squads of soldiers, their rifles loaded with ball cartridges. Americans had been warned to stay indoors and we were unable to leave our hotel for some days.

The trials of the second boat and the training of its crew duplicated our experience with the first boat. No hitch impeded the work. The Japanese naval officers were quick to master the intricacies of submarine navigation. They were diligent in following instructions and did nothing they were told not to do. They were admirable pupils and no teaching was lost on them. Especially did they note our explanation of why we did certain things and refrained from doing others. For example, while submerged in Tokio Bay we found a main hatch leaking. I immediately gave orders to blow out the main ballast tank and come to the surface. After the tank was empty we opened the hatch and detected the fault. The Japanese officers could not understand why we blew out so much ballast in order to open the hatch. I explained that if we had blown out only a small volume of ballast the vessel would have only a few inches of freeboard, and opening the hatch would then have endangered her, as a sudden swell might carry enough water through the hatch to sink the boat, owing to the small amount of buoyancy. With the main ballast tank quite empty we had several feet of freeboard, which safeguarded any risk of accident. The effective reaction on them of this demonstration of a danger easily incurred and as easily averted has more than assured me that henceforth no Japanese naval officer ever opened the hatch on a submarine without first providing for ample freeboard. I cite this instance to show their eager aptitude for following instructions.

Holland had meantime designed another type of boat, the plans for which were sold to Count Matsukato, who operated a shipyard at Kobe. The latter in turn contracted with the Japanese government to build two boats from these plans, and three American technicians of note superintended their construction. I was anxious to see these boats, but, despite my acquaintance with Lieutenant Ide, the Japanese officer in charge of the work for his government, red tape barred me from access to the Kobe Yard. The boats were duly launched and put in commission.

In April, 1910, one of these boats was lost with Lieutenant Sakuma, its commander, and the crew of fourteen men, during maneuvers in Hiroshima Bay. Lieutenant Sakuma's story of the tragedy lay in the conning tower when it was raised by a wrecking party from the cruiser *Toyohashi*. This sailor's log, hereunder quoted, recorded the creeping approach of a slow but certain death between 10 A. M. (after total immersion) and 12:40 P. M., the lingering ordeal thus lasting two hours and forty minutes. It was addressed to the Navy Department as a confidential report:

Words of apology fail me for having sunk His Majesty's submarine No. 6. My subordinates are killed by my fault, but it is with pride that I inform you that the crew to a man have discharged their duties as sailors should with the utmost coolness until their dying moments.

We now sacrifice our lives for the sake of our country, but my fear is that the disaster will affect the future development of submarines. It is therefore my hope that nothing will daunt your determination to study the submarine until it is a perfect machine, absolutely reliable. We can then die without regret.

It was while making a gasoline dive that the boat sank lower than was intended, and in our attempt to close the sluice the chain broke. We endeavored to stop the inrush of water with our hands, but too late, the water entered at the rear and the boat sank at an incline of 25 degrees.

When it touched the bottom it was at an angle of 13 degrees. The current submerged the electric generator, put out the light, and the electric wires were burned. In a few minutes bad gas was generated, making it difficult for us to breathe.

It was at 10 A. M. on the 15th inst. that the boat sank. Surrounded by poisonous gas, the crew strove to pump out the water. As soon as the boat sank the water in the main tank was being pumped out. The electric light was extinguished and the gauge was invisible, but it seems the water in the main tank was completely pumped out.

The electric current has become useless, gas cannot be generated, and the hand pump is our only hope. The vessel is in darkness, and I note this down by the light through the conning tower at 11:45 A. M.

The crew are now wet and it is extremely cold. It is my opinion that men embarking in submarines must possess the qualities of coolness and nerve, and must be extremely painstaking; they must be brave and daring in their handling of the boat. People may laugh at this opinion in view of my failure, but the statement is true.

We have worked hard to pump out the water, but the boat is still in the same position. It is now twelve o'clock. The depth of water here is about ten fathoms.

The crew of a submarine should be selected from the bravest, the coolest, or they will be of little use in time of crisis—in such as we are now. My brave men are doing their best.

I always expect death when away from home. My will is therefore prepared and is in the locker. But this is of my private affairs. I hope Mr. Taguchi will send it to my father.

A word to His Majesty the Emperor. It is my earnest hope that Your Majesty will supply the means of living to the poor families of the crew. This is my only desire, and I am so anxious to have it fulfilled.

My respect and best regard to the following: Admiral Saito, Minister of the Navy; Vice Admirals Shinamura and Fujii, Rear Admirals Nawa, Yamashita and Narita—the air pressure is so light that I feel as if my eardrums will be broken—Captains Oguri and Ide, Commander Matsumura, Lieut-Commander Matsumura (this is my elder brother), Captain Funakoshi, Mr. Narita, and Mr. Ikuta—it is now 12:30 P. M. My breathing is so difficult and painful.

I thought I could blow out gasoline, but I am intoxicated with it—Capt. Nakano—it is now 12:40 P. M.

Here the record ended. The crew had been suffocated by carbonic-acid gas.

Introducing the submarine into the Japanese navy led to agreeable contacts with various personages of high station, notably the venerable Prince Ito, who had watched his country become Westernized from the time of Captain Perry's visit, and Admiral Togo, in command of the Japanese fleet, who told me many stories of the war on the high seas. There was no doubt of our success, which was due in large part to Japanese promptitude in getting things done and to native eagerness to learn the ropes. Admiral Saito, Minister of Marine, honored us with a Japanese banquet at the Maple Club, Tokio, where we met about a hundred guests, most of them naval officers of rank. These officers appeared in regulation uniform; the host himself was distinctive in native garb. The room was entirely bare of furniture. Before entering, a formality to be respected was the removal of our shoes, a requirement of etiquette that meant spending the whole evening in stockinged feet. This was a new departure for us; going about shoeless, to our Western eyes, marred the effect of correct evening clothes.

Each guest sat on the floor, which was laid with matting. I was not accustomed to this form of rest, and an upholstered box was provided for my comfort, but as guest of honor I insisted on conforming to Japanese custom and took my place with the others on the floor. A beautiful geisha girl was assigned to each guest to wait upon him and sat directly in front of her charge, so that the number of these handmaidens equaled that of the company.

The banquet equipment consisted of a jug of saki (the national drink), a bowl of water, a saki cup, and chopsticks. The first course was raw fish, taken out of the water less than fifteen minutes before being served. Consuming raw fish with chopsticks was difficult, but the portion we could partake with such awkward implements more than satisfied our taste.

During such repasts it was the custom for the host to sit in front of each guest, drink to him from the saki cup and wash out the cup in the water bowl, following which the guest drank from the same cup. Before the function ended each guest returned the compliment by sitting in front of the host and going through the same rite. With a hundred guests exchanging drinks with the host, the imbibing was apt to become more or less strenuous if these amenities were faithfully observed. The banquet lasted until the small hours of the morning.

Our work in Japan was finished by the middle of September, when we left Yokohama on the Korea, homeward bound, in company with a congressional party who for several months had been investigating conditions in the Far East.

CHAPTER XX

Accessions to United States submarine fleet.—The *Octopus.*—Testing her hull strength two hundred feet down.—Contest with the *Lake* at Newport to obtain $3,000,000 contract for further boats.—Social effect of submarine's presence at fashionable resort.—Features of the *Lake.*—Tests provide a continuous gala for Newport crowds.

OUR own government meantime saw the need of increasing the navy's submarine fleet. Contracts for four more Holland boats had been awarded and were being built at the yard of the Fore River Shipbuilding Company at Quincy, Massachusetts, where I found our plant and force had been transferred. Three of the boats were of the B class, an outgrowth of the *Adder* group, and became a lively little trio known in the navy as the *Viper, Cuttlefish,* and *Tarantula.* They were of 170 tons displacement when submerged and had a surface speed of nine knots, and eight knots under water. The fourth craft was the *Octopus,* of the C class, whose features marked a notable development in our work, and upon whose performances depended the obtaining of further contracts under an appropriation for $3,000,000 voted by Congress.

Submarines were becoming larger, faster, and more efficient than their predecessors, and the tests they faced were accordingly more searching. The *Octopus* was an advance on the *Viper* class. She was 105 feet long, had a fourteen-foot beam, and drew twelve feet of water in a light condition. She was of 270 tons displacement, had 500 h. p. on the surface, and was equipped with twin screws driven by gasoline engines. She had a capable electric storage-battery system for use in submerged work. Under water she was driven by two 50 h. p. electric motors, with which she made a speed of ten knots. When operated by her gasoline engines she ran at eleven nautical miles an hour on the surface. Her twin screws were a development from the single screw of her forerunners. A system of submarine bell signals enabled her to hold communication with the surface. Her war equipment was four 18-inch torpedo tubes. In her design she embodied the lessons we had learned in the operation of submarines both in our own and in foreign navies.

The launching of the boat in October, 1906, signalized an extensive program of experimental work. The first boat of a new type always required a long and painstaking feeling out of manifold details, sometimes causing infinite changes before her showing satisfied us. The boat had to distinguish herself, and we operated her on the surface and submerged almost daily for three months, to determine her points until the river froze over and the thick ice halted further work.

The structural strength of her scantling and plating made her a much stiffer and stouter boat than any of her predecessors. We had been mindful of serious accidents which had befallen submarines in foreign navies. Where the boats sank to great depths the hull structure showed signs of failing under the enormous pressure. The hulls became distorted and leaks developed, both at the seams and at the outlets of pipes and other openings. We built the *Octopus* to enable her hull to withstand such ordeals in deep water.

Her framework attracted attention in an exhibition run we made for a party of ladies who had never been in a submarine. After the boat was sealed up for submerging one of them asked how thick the hull plating was directly above her head. We told her about half an inch. She doubted if this thickness was enough to insure safety and we therefore recommended that she occupy another part of the boat where the plating was stouter. She changed her position accordingly and expressed relief.

The Navy Department wanted to be assured of the boat's capacity to endure water pressure at a great depth. To meet this requirement they called on us to submerge the *Octopus* 200 feet and keep her there for fifteen minutes. Such a test for a submarine had not been made before. It was necessary either to send down a crew in her or lower the boat by apparatus from the surface. Our own belief was that the hull could withstand a pressure much greater than 200 feet. At this stage of submarine development, however, I did not propose to jeopardize the lives of the crew by risking an accident at a depth to which we had not hitherto ventured. Our decision to lower the boat by a heavy derrick, however, was not welcomed by our crew, each of whom had volunteered to go down without having any communication with the surface.

We ballasted and sealed up the boat and lowered her some six miles east of the Boston Lightship by the help of the largest floating derrick we could find in Boston harbor. She slowly sank with about two thousand pounds of negative buoyancy. At a depth of fifty feet we stopped lowering and raised her for examination. Then down she went again to 100 feet. Some of us were anxious about her disappearance to this depth; we had no means of knowing just how she was enduring the ordeal. However, we had taken the risk of burying her in deep water all by her lonesome and continued lowering her to 140 feet. Then the operator on the winch found he had reached the end of the line, and we could go no farther. Our lowering gear was too short. The boat was hauled back to the surface, unharmed by the pressure, and returned to our base.

Several weeks elapsed before this test was fully carried out. Well off the Boston Light we again swung her upon chains from a derrick, with her ballast tanks filled, and dropped her to the extreme depth of water hereabout, which was 205 feet, keeping her down on the sea bed for the ten minutes required. On hauling her to the surface her structure was found intact and undamaged, and there was no evidence of leaks. The total pressure at the depth she reached, over the whole surface of the boat, must have amounted to about 15,000 tons.

The middle of April, 1907, found the *Octopus* at Newport to undergo competitive tests with the *Lake,* built by the Lake Company at

Bridgeport, Connecticut, the navy being now prepared to award further contracts, under the large congressional appropriation available, to the builder who could produce the best type of submarine of American invention. The chances of the Holland boats adding to their laurels depended upon how the *Octopus* acquitted herself. She was a government boat, and, having no craft of our own for the test, we obtained the consent of the navy authorities to our using her. We had trained the crew to the pink of condition. Proficient to the last degree, they formed as finished a group of professional submarine experts as undersea navigation had produced up to that time.

Convoyed by the steam yacht *Starling,* the *Octopus* left Fore River late in the afternoon on April 19th for Narragansett Bay, where our trials were to take place. We tied up in Provincetown until the following morning, venturing to leave there at daylight for the run around the cape and over Nantucket shoals with a gale blowing and a high sea, but before rounding the cape we decided that a good harbor was more desirable in that kind of weather than the open sea in a submarine. We thereupon turned back into Provincetown, a quiet little place where there was little for an active crew to do except touching up and regrooming the *Octopus* for her coming tests. A Sunday intervened, and in company with the president of the company which was building the Holland boats, we attended church in conformity with our custom on any Sabbath that preceded our undergoing important trials with their attendant dangers. The presence of every member of my crew at divine service was highly stimulating, and strengthened my belief that the coming trials would be crowned with success.

The following morning, the wind and sea having subsided, we left Provincetown at daylight and made a splendid run around the cape and over the shoals, tying up for the night in Vineyard Haven. The next day we were in Newport, our base for the trials, and there we waited several days for the appearance of the naval Board of Inspection and Survey who were to conduct the tests. The *Lake* had arrived on the scene several weeks before, and had been undergoing government trials.

The town's interest in the pending contest between the two boats had reached a diverting stage. A New York newspaper published the following lively account of the social effects produced by the submarines on the fashionable resort:

> All Newport walks and talks sailor fashion. "Are you in diving trim?" is the greeting of wife to husband in millionaire's row just before the morning bath. The festive cocktail nightcap is swallowed to the nautical toast, "Here is the way to submerge." Strange to say, the exclusive set have enthusiastically fallen into the craze first adopted by the Newport shopgirls. He or she who can invent a new application of marine language to fit the situation is the lion of the hour.
>
> Two well-known colonists passing in automobiles stopped to gossip a second in transit.
>
> "How is your periscope?" said one of them.
>
> "Nothing but sea serpents and octopi in sight," was the response.
>
> "If I should die this morning I hope the sea will break in and flood me."
>
> "There isn't enough water in Narragansett Bay to satisfy the submarine to-day."
>
> Everybody in Newport knows the captains and crews of the two underwater boats and most of their history. Everybody has a favorite. Hotel clerks hold thousands of dollars of stake money wagered by residents each night as to the outcome of the speed contest each day.

Betting was general. Saloons and drawing-rooms alike gambled on the two boats. The crew of the *Octopus* was confident of success and offered to meet all comers to the extent of their financial resources.

The *Lake* boat was a developed type of the *Protector,* which had earlier contested, but without result, with the *Fulton* for government submarine contracts. She had a displacement of 250 tons and was 85 feet long. Her features duplicated, but on an extended scale, those of the *Protector,* which were described in a previous chapter in connection with the *Fulton* tests. Being a boat of the even-keel type, the *Lake* submerged without altering her horizontal trim by the operation of her hydroplanes, or horizontal steel wings fixed at the sides of the vessel, which were so tilted as to cause the water to impinge against them and drive the boat down to the desired depth. Like the *Protector,* she had a removable device for insuring greater safety to her crew when under water in the form of a drop lead keel, five tons in weight, which could be readily freed from the bottom of the boat in case of danger by pulling a lever, thus giving the craft sufficient buoyancy to return to the surface. The boat had endured a depth test similar to that which the *Octopus* underwent, to determine the seaworthiness of her hull under great water pressure. She voluntarily sank to the bottom at a depth of 138 feet with her crew aboard, returning to the surface about five minutes after disappearing. While resting on the bottom she was subjected to a pressure of fifty-two pounds to the square inch at the axis of the boat, and withstood this heavy pressure without any strain on her stout and water-tight hull.

The boats went through their tests alternately for ten days in the course of the month of May, 1907. One day the *Lake* would carry out a series of trials prescribed by the naval board; the next day the *Octopus* would be subjected to similar tests. The boats accordingly furnished a gratuitous submarine gala for the Newport crowd day by day.

Our official speed was far beyond the Navy requirement. We were able to operate the *Octopus* submerged at her top speed with a variation of less than twelve inches from a given depth. This has been found next to impossible even in our modern submarines, which are necessarily great improvements over the *Octopus* class.

CHAPTER XXI

The *Octopus* goes under water for twenty-four hours to meet Navy requirements.—Crew face ordeal with indifference.—All in the day's work.—How a night and day was spent under Narragansett Bay.—Monotony of life below the waves, shut from the world, more felt than fear of drowning.—Jules Verne overcolored the attractiveness of undersea existence.—Naval board approves the Octopus as the best submarine so far built.—More boats for navy.—Gasoline engines displaced by the Diesel heavy-oil type.

THE supreme test required in the Newport trials was that we should remain totally submerged for twenty-four hours without communication with the shore. Holland himself had undergone this immersion in his first boat, remaining at the bottom of the Passaic River a night and a day. In later boats the longest submergence we had made was fifteen hours, which we achieved with the *Fulton* in 1904. The ill-fated French boat *Lutin* had exceeded this length of time under water, remaining seventeen hours in the harbor of Bizerta, Tunis, but she did not survive the test and was found wrecked, with her crew dead, 137 feet below.

The deep-water ordeal undertaken by the *Octopus* took place at Bradford, which is on

Narragansett Bay, a few miles above Newport.

There is little romance in a dip of twenty-four hours under old ocean. When it became known at the Fore River Yards that the United States government demanded, among other tests, that I should take my crew of thirteen into the hold of the *Octopus* and remain that length of time beneath the waves, the order did not create any excitement. This, probably, was due in a large measure to our confidence in the boat. Most of us knew the soundness of her construction. We also reposed the fullest confidence in the boat's designer, Lieutenant Spear, whose achievements in submarine-boat building had brought him a world-wide reputation.

When the hatch was fastened down we sank quietly to the bottom of Narragansett Bay at four o'clock on the afternoon of May 15th. I had with me the following petty officers and crew, precisely the same number as were on board the French submarine *Lutin:* H. Momm, mate; P. L. Glenn, diver; W. F. C. Nindeman, gunner; J. W. Hume, E. H. Payne, C. Bergh, C. Kuester, C. Morgan, C. B. Miner, C. Bergstrom, R. Phinney, C. Lippincott, H. Gamber, and Marcus West.

Every member of this crew hailed from Quincy, with the exception of West, who was a Salem lad. The crew had been trained under my supervision, and acted as a unit. They were as brave and cool a set of men as ever gathered together under any flag. Momm, the mate, was a man of great experience and resource. Nindeman had sailed all over the world. He was one of the few survivors of the ill-fated *Jeannette* expedition.

The men were fully alive to what might happen to a vessel in the course of a twenty-four hours' submergence beneath the waves. But they were quite cheerful about it. Nobody indulged in gloomy forebodings. There was no looking up and taking a last glimpse of the sky, not any theatrical attitudinizing of the kind.

They faced their contemplated twenty-four hours' imprisonment as they would any other task. It was undertaken with the knowledge that the eyes of the world—at least the eyes of the great navies of the world—were upon them.

When the hatch was closed and the necessary preparations were completed I glanced at the crew, and experienced a thrill of pride as my eye rested on the well-knit and hardy forms and the fearless, resolute faces of my companions.

STERN OF SUBMARINE SHOWING DIVING RUDDER UNDER SURFACE

"Boys," I said, "we are now going to be locked up together for quite a spell, and we must try to make it as little tedious as possible. Let's give three cheers for the boat and her builders."

One of the tests we had to make was to run the motors for four hours after starting up. This was done by putting her nose against the dock so that, although running the motors, we really did not alter our position materially. Two tenders, the *Hist* and the *Starling,* were in attendance for fear some vessel, ignorant of our presence beneath them, might, after we had sunk to the bottom, drop a heavy anchor on us and thus crush in the shell of our little craft.

We had dinner at six o'clock. The boat had been entirely cut off from the outside air and we were wholly dependent upon our compressed, or "canned," supply. The great motors gave out a strange, humming sound. The crew conversed at first in low, constrained tones, but became more lively as the meal progressed. Everybody sat down to dinner except two men on watch. The meal was prepared by Marcus West, who acted as *chef* during the test. He used an electric stove, and care was taken to cook nothing which would give out noxious fumes. Our menu was as follows:

Consommé
Roast chicken
Cold roast beef
Cold ham
Chicken salad   Lobster salad
Vegetables
Boiled potatoes
French green peas
String beans
Dessert
Pie   Cake   Crullers
Tea   Coffee

There were no cigars; no lights, except the electric bulbs, being allowed in the boat. This abstention from tobacco was the only hardship undergone by the crew during their stay on board the vessel.

By seven o'clock the meal was over, the dishes were cleared away, the cloth was removed, and the men had disposed themselves about the boat, lounging, chatting, reading, and a game of freeze-out was started at the table.

At eight o'clock, after running the motors for four hours, as I have described, the men were ordered to stations, the boat trimmed by admitting water to the ballast tanks, and we commenced to descend. There was a slightly perceptible jar; the *Octopus* quivered just a little from stem to stern; then she heeled over a trifle to port, righted, and rested lightly on an almost even keel, in the mud and ooze at the bottom of Narragansett Bay. The men returned to their game and, now that the great wheels of the motors had ceased to revolve, except for the low buzz of voices or an occasional ripple of laughter from the card-players, profound silence prevailed.

The first thing I did after submerging was to set a watch of two men, which was changed every two hours. The duties of these men were to look after the interior of the boat, so that if any leak occurred they could remedy it.

The *Octopus* had a bell immersed in a tank of water, which could be struck by means of air pressure. On the *Starling,* her steam-yacht tender, was another bell. This equipment, by means of which we communicated with each other, consisted of a set of telephone receivers in addition to the bells. The same device is in use on lightships and many sea-going craft. We signaled every hour to the *Starling* that all was well. We had a special code of our own by which we exchanged these safety signals.

I am of rather an unimaginative turn of mind, but even for me it was not difficult to fancy that the terrible marine engine of destruction in which we were confined was there for other than peaceful purposes; that our consorts were foreign warships searching for us; and that presently it would be my duty, as commander of the craft, to send crashing through the side of the gunboat which lay almost directly above us a torpedo which would shatter her to fragments.

About nine o'clock I was up in the conning tower when I heard an exclamation beneath me, and, looking down, saw "Skipper" Glenn. His face wore a broad smile.

"What is it?" I asked, getting back to earth again.

"Lippincott has just cleaned up a big jack pot."

I climbed down the ladder and walked over to the table. The men were absorbed in the game. They might have been in the forecastle of a man-of-war or the smoking room of an Atlantic liner, for all the difference the situation made with them. So much for custom.

At ten o'clock I ordered all hands, except the two on watch, to turn in. The rubber mattresses were blown up with compressed air, all lights but one solitary shaded electric bulb were "doused," and soon my crew were sleeping as peacefully and soundly as they would have done in their quarters at the Fore River Yards. I also stretched myself upon my mattress, but the sleep which came so readily to the others did not at first answer to my call. For the next two hours, and in fact until long after midnight, several thoughts crowded upon me to which my mind had hitherto been a stranger.

As I half dozed on my rubber mattress there suddenly appeared to me in great black letters a headline I had read in the Boston *Globe* months before, "Submarine in Fatal Plunge Drowns Fourteen." Instantly all the terrible details of the sinking of the *Lutin* flashed across my mind. I seemed to see the ill-fated craft 137 feet below the surface in the harbor of Bizerta, Tunis, the overturned accumulators, the stifling fumes, the struggle for breath in the suddenly darkened hull.

I roused myself from this gloomy reverie, knowing well the careful construction of our craft and that I had with me an expert crew. No fear of a like disaster to the *Octopus* further disturbed my dreams.

Every hour during the night we exchanged code signals with the *Starling*. The stereotyped phrase, "—— bells, and all's well," became monotonous. The muffled clang of the signal gong was the only sound which broke the stillness of the night watches.

At about 6 A. M. I got up and, waking the mate, we made together a thorough inspection of the hull. Notwithstanding that we went over every inch of the interior surface we could discover no signs of leakage. There was not even any moisture on the inner shell of steel.

At about seven o'clock I ordered the hands turned out. The freshness of the air was very noticeable. Up to this time we had had no occasion to draw upon our compressed supply. Some surprise was expressed that the air was not more vitiated. The exposure of litmus showed but slight discoloration from the presence of carbonic acid.

The air flasks had a pressure of 2,000 pounds to the square inch. These flasks were tested to double the working air pressure placed upon them.

Of course it didn't seem exactly like getting up in the morning.. There was nothing but the ship's chronometer to assure us that it was 7 A. M. After a look through the periscope I piped all hands to breakfast.

The following menu cheered them:

Fruit
Oranges Bananas
Oatmeal
Bacon and eggs
Saratoga chips
Rolls and coffee

At eight o'clock we struck the usual signal to the *Starling,* and, in addition to the stereotyped answer, received a brief résumé of the morning's news. I have forgotten what it was exactly; but there was something about a Peace Conference, which sounded funny enough when read out to the crew of the *Octopus,* probably the deadliest weapon of war then invented. To while away the time I started and encouraged a discussion upon disarmament. That the crew of the *Octopus* were born fighters may be inferred. No peace party could be discovered among them.

About nine o'clock one of the boys came up and informed me that "C. Bergh had an organ." I did not at first exactly comprehend how an instrument of that magnitude had been smuggled into the interior of the *Octopus* through her narrow hatchway; but I was ultimately given to understand that Mr. Bergh's instrument was a mouth organ. The sailor modesty of Mr. Bergh would not permit his essaying anything more classic than "Waiting at the Church" and "Home, Sweet Home," but he was loudly applauded. I doubt if Caruso ever had a more appreciative audience. Good music or bad, it broke the tedious spell which seemed to settle on the crew after breakfast was over.

This brings me to the reflection that, even in time of war, the monotony of life below the waves, shut out from the world, excluded from a view of the fleeting clouds and from the sound of the waters, except as some faint murmur reaches the ear through the double steel shell of the submerged craft, must always constitute one of the chief obstacles to prolonged existence in a submarine. The feeling of being cut off from the world, not the fear of suddenly intruding waters and death by drowning, was uppermost in the minds of the imprisoned. The mere fact that one could not breathe the air of heaven created a maddening longing to be once more on the surface. The knowledge that you were confined within the steel walls of your submarine prison made you long for freedom.

Jules Verne drew an enticing picture of life below seas in his splendid romance of the *Nautilus,* but I am unable, from my own experience, to say much for its attractiveness. Perhaps some embittered recluse like Captain Nemo might find it enjoyable; but we must remember that the Frenchman's submarine was a very different affair from the fighting machine in which we were imprisoned. The involuntary prisoners of the *Nautilus* were conducted to a splendid dining apartment glittering with china, porcelain, and glass, and were fed with strange, delicious dishes prepared from the flora and fauna of the sea. They had access to a library of 12,000 volumes, and an immense drawing-room containing a grand piano and with walls hung with paintings and tapestries of rare value. The glass windows of the *Nautilus* also opened up the many wonders of the deep, which sight was denied us in the hold of the *Octopus.* Nor were we provided with Captain Nemo's armor-like suits which enabled him to leave his craft and explore the wonders at the bottom of the ocean.

In one respect, however, we felt that we were as well off as Captain Nemo and his crew. Jules Verne tells us that in the *Nautilus* men's hearts never failed them. And so it was with those bottled up in the *Octopus*, knowing well the skill and care that had been put into her construction.

When the time of our imprisonment had expired the *Octopus* responded instantly to the action of her powerful pumps, and as the water ballast was forced from her tanks she gradually, and on an even keel, rose up through the water, freeing herself without a shock from the ooze in which she had been embedded, and riding securely upon the surface.

When the hatch was opened and the members of the trial board descended into the hold, they found the atmosphere unimpaired. So little of our compressed-air supply had been used—only one-forty-fifth—that at the rate of consumption, providing we had been sufficiently stocked with water and provisions, we could have remained for forty-five days beneath the waves.

The naval board decided that the *Octopus* was the best type of submarine boat so far built. The outcome was that seven more Holland boats were built for the navy, four of them duplicating the *Octopus*. The remaining three registered a further growth from that type.

MORNING BATH ON SUBMARINE

The group represented the last Holland boats using gasoline engines. The government thereafter required the installation of oil engines of the Diesel type, to eliminate the danger arising from the use of gasoline. Later boats built were installed with such engines of English design, this being the only Diesel type then available. Still later marine engines of the heavy-oil Diesel type were built in this country and installed in submarines. Development of the Diesel had been well advanced in Nuremberg, Germany, before American engineers turned their attention to the type. After examining all known engines so classified, they decided that the Nuremberg product was the best so far developed for submarines, and rights for construction in the United States were acquired. The first Diesel engines built in America had various defects, the chief of which was their complicated operation. The outcome was a newer type which endured hard service and worked with a high efficiency in many of our modern submarines. The change from gasoline to heavy oil revealed that with a given quantity of the heavier fuel the number of horse-power hours obtainable was twice that from a like quantity of gasoline. Thus a boat having a given fuel-tank capacity could double her radius of action with the change from gasoline to heavy oil.

Between 1908 and 1914 the Electric Boat Company, the builder of the Holland type, added sixteen submarines to the United States navy. By the latter year, when the World War came, the government had about thirty boats, including the earlier type of the *Adder* class, which by then, had become more or less obsolescent.

CHAPTER XXII

The third American submarine flotilla, typified by the *Salmon*.—Achievements of 1910.—Germany's developments from the *Holland* type. — Submarine strength in the World War.—Growth of Holland boats from the 1895 boat to the *Schley*.—Inventor's withdrawal from the industry he created.—Denounced submarines developed by his successors as unseaworthy death traps.—Expansion of his invention beyond his scope and control.—Declining years occupied in devising a flying machine.—His death just before the World War's outbreak.—German submarines evolved from the *Holland* type realize his early aims in seeking to weaken British naval power.

The performances of the seven Holland boats built after the *Octopus* test dispelled any remaining doubt as to the practical value of the submarine. Doubt naturally lingered in view of the long apprenticeship such craft required even before emerging from the final experimental stages.

This group of boats, three of which were of enlarged displacement (337 tons submerged), formed the third American submarine flotilla. They achieved noteworthy records in the naval maneuvers of 1910. A preliminary run of the entire flotilla from Newport to Gloucester (150 sea miles) was made submerged except when passing the Nantucket shoals, where the slight depth of water required the vessels to run awash. Beyond making needful ascensions to the surface at night to recharge the storage batteries, the runs were uninterrupted and without mishaps, and lasted twelve hours at a stretch. Officers and crew showed no ill effects from being under water two days and nights. A score or more of surface ships the boats passed *en route* had no suspicion of their proximity. Such a voyage at the time would have been notable enough if achieved by a single vessel. Accomplished by seven boats, it registered a more important feat—uniform efficiency and organization in the control of a flotilla. One of the boats, the *Salmon,* the same year made a voyage from Boston to Bermuda and back, covering about 1,500 knots under its own power without external assistance. This trip finally proved the habitability and safety of American submarines at sea in any weather. In these post-war days such feats are of no account, but it is needful to recall that in the pre-war period the submarine was rightfully regarded as the wonder of the deep.

The developed Hollands made equal strides in foreign waters. Reviewing the submarine situation in 1911, *Engineering,* a leading British technical organ, commented:

While it is probably too much to expect that every possible virtue in an under-water boat will ever be combined in any one design, or that, having been combined, there will be unanimity of expert opinion as to that fact, nevertheless the conclusion seems to be warranted that the British Admiralty made no mistake when it selected the Holland type as the basis for the development of British flotillas. Their judgment as to the soundness of the principles involved in the designs . . . has certainly been confirmed in a gratifying way by the wide acceptance of the same general type, not only in the United States, but in Europe, Asia, and Africa.

Germany, like Great Britain, adopted the Holland type, only to depart from it. She tarried long before getting into line with other nations, but when she moved in submarine construction, she moved fast. Her naval experts favored the Holland principle as the most efficient for undersea service, indorsing the opinion of Krupp's, who evolved and developed the *Germania* class of boats, which became the standard type of the German navy.

Germany's chief contribution to submarine science, in fact, considering the unsurpassed success she made of her U-boats, lay in her adoption of the Holland type. It is doubtful if her U-boat record would have been so outstanding had she made a different choice. Though the greatest user of submarines, Germany, however, had no hand whatever in their early development. Her achievements were confined to their operation. Certainly her technicians made notable contributions to submarine equipment in the production of the oil motors I have previously referred to. Using them in her own boats, she developed a class of submarines which were unmatched in their aggregate record by those of any other nation. But beyond building a good engine she added no feature of great novelty to under water navigation. Her submarine plumes were borrowed, mainly from the United States, where the efficiency of modern undersea craft had its real genesis.

At the outset of the World War, America's little under-water fleet of thirty, in contrast with the expanding tonnage of the European nations, stood out as a glaring example of unpreparedness, of letting foreign powers stride ahead in producing undersea craft. Many of the foreign boats came from American plants, which hummed with submarine orders from abroad. Germany began turning out boats in her own and in Belgian yards at the rate of two every three weeks and then one a week, with varying displacements of 200, 800 and 1,200 tons. When the United States entered the conflict in 1917, the Central Powers had an impressive submarine navy. The Allies were not far behind. Yet by that year the United States had added only four to its submarine fleet. Its entry into the war naturally enforced a considerable addition.

What the submarine became in the war period formed a startling enough contrast to its humble forerunner—the Holland boat of 1895. Twenty years, relatively speaking, had developed a midget into a giant. The *Holland* type of 1895 was a little craft 53 feet long, displaced 73 tons submerged, ran 5 knots an hour under water and 7 on the surface, and had a cruising radius of 200 miles. By the decade following the length had increased to 82 feet, the speed to 8 knots submerged and 8¾ on the surface, the displacement nearly two and a half times and the cruising radius to 850 miles. By 1910 the length was 147 feet, the submerged displacement 434 tons, the submerged speed 10½ knots, the surface speed 14 knots, the cruising radius 2,300 miles.

In 1913 came the 913-ton boat. Up to that year the submarine really belonged to coast defense, though the *Salmon,* as mentioned, had shown her capacity for oversea service. Existing boats at this period were best suited for harbor and coastwise scoutwork, their operation mainly confined either to the harbor itself or close to its mouth. As such, the earlier submarines were really dirigible mines, replacing fixed mines, which proved more dangerous to friend than to foe. They duly came to pass from port to port under their own power, thus broadening their field of action. Their utility for coast protection, instead of the ancient port mines, was specially recognized by Great Britain, where all such outlying under-water defenses at her chief naval and commercial ports were abolished and the protection of these harbors intrusted to submarine and torpedo boats.

The big 1913 boats approximated to the larger German submarines which startled the world with their deadly efficiency in the early stages of the World War. With 1915 came the boat displacing 1,454 tons under water, capable of a submerged speed of from 10½ to 11½ knots, a surface speed of from 14 to 20 knots, and a radius of action extending between 2,300 and 3,000 miles. The first of this class was the American *Schley* which reached a high mark in the progression the submarine had been making all along toward greater habitability, ease and certainty of control, safety, and range, trustworthiness and effectiveness of torpedo armament, and, most of all, in staying power on the high seas in face of wind and weather and away from a submarine base. The boat's chief features embraced diving rudders both at the stern and at the bow, a hull divided longitudinally into seven water-tight compartments and four powerful torpedo tubes at the bow and two at the stern.

The Holland submarine had far outgrown the conceptions of its inventor. Various modifications of the type, in fact, especially those produced in American and British yards, he repudiated as any offspring of his. As early as 1904 he severed his connection with the company which had acquired the patents covering his invention, and the Holland boats henceforth were developed without his aid. Differences with the company led to litigation by both sides. The inventor charged that the company had failed to fulfill the terms of the contract under which the patents were assigned. He complained of being forced into the background after the assignment of the patents, of his advice and experience being disregarded, and of the management and construction of new vessels being placed in the hands of engineers unfamiliar with submarine construction. He passed many strictures on the course the navy and the Holland-boat builders followed in improving the type, and had clashes with Admiral Capps, of the Naval Bureau of Construction, among others.

"Uncle Sam's officials turned on me because I criticized alleged improvements made on the Holland," he protested in 1909. "I did not graduate from Annapolis. I am not disloyal or without patriotism, but I am ashamed of the boasted efficiency of our bureaus of construction. Nations got a terrible sample of poor submarine construction when the A-8 went to the bottom in English waters. I then charged the English Admiralty with careless construction, and our Admiral Capps charged me with indiscretion. When I review the supposed improvements in submarine work by our youthful naval architects, graduates of Annapolis, I am severely arraigned by these selfsame youngsters. They presume to know more about submarines than I do. They favor nothing but what comes from England. Uncle Sam will have nothing to do with me, and I am sure I have as little respect for English naval constructors as they have for me."

Nevertheless the Holland boats, as the record shows, grew apace in efficiency. They became the product of the teamwork of many minds, building upon the foundations the inventor laid in his early boats. Holland blazed the trail; others followed it.

"He made many complaints to Congress," Burton J. Hendrick remarked in recounting Holland's work after his death in 1914, "denouncing the so-called Holland boats as unseaworthy 'death traps.' His last days were made unhappy because he had failed to influence Congress and the public; almost with his last breath he prophesied disaster to his country. To what extent these lamentations represented the disappointment of a neglected inventor and to what extent they had a real basis, only events can show."

Events at least showed, as this story does, that Holland builded better than he knew, but that, like many another invention, his submarine, in other hands, expanded beyond the scope and control of its inceptor.

He occupied his later years with devising a boat which adhered to principles from which the developed Holland boats had departed. "I conceived the first submarine. Why cannot I conceive something better?" he said at sixty-seven. The new boat was to travel across the Atlantic, follow a battleship fleet, make a speed of twenty-five knots an hour, and ride as safely on the high seas as an ocean greyhound. Admiral Capps rejected the device, and nothing came of it. Nor did any success attend his design for a flying machine, to which he devoted his restless mind about the time the Wright brothers were testing their first airplanes. There is no record that he ever ventured on a flight in the device.

Rheumatism gripped him periodically and curtailed his activities. Unknown to his neighbors as a man of any note, he lived in East Orange, New Jersey, his small frame stooping, his gait awkward, his manner nervous, due to his near-sightedness, which increased with the years, yet keen-brained, studious, and ambitious to the last, spending much of his time at the rear of his home, where he had a workshop sealed with various locks. He did not marry until nearly fifty, and in his declining years was surrounded by a growing family of five—the eldest of whom is John P. Holland, Jr.

Holland died two weeks after the outbreak of the World War in 1914. The newspapers dismissed his death in brief paragraphs. Germany's invasion of Belgium and Great Britain's war preparations were events of greater moment. Equally eventful as news of infinitely more weight than the passing of a forgotten inventor was the sinking by a German submarine of the British warships *Aboukir, Cressy,* and *Hogue* in the North Sea six weeks after his death. The intimate connection with Holland of that sea tragedy, which stood out among the first of many to follow, was not noted. A submarine developed from the Holland type had finally achieved what he had vainly set out to do with the *Fenian Ram*—it had dealt a telling blow at the British navy.

Holland has no monument, and perhaps he needs none. His genius projects sufficiently as a powerful though unrecognized factor in the momentous maritime events of the World War.

CHAPTER XXIII

Future expansion in size, power, and gunnery.—The pace Germany set.—The Diesel electric drive.—Great Britain's and Japan's big submersibles.—The American V class.—Progress halted by lack of money.—The Flamm 7,000-ton submarine.—The submersible battleship.—United States naval foresight produces plan for one of 20,000 tons.—Italy also looking ahead with similar plans.

As already seen, the war's close left the status of submarines at a crucial stage. It was alike denounced and valued. Recognition of its worth finally overcame the odium cast upon it. Its outlook now promises a future expansion in structure, power, speed, and equipment far beyond the scope of any type yet built or building. There are foretokens of a growth which may lead eventually to a realignment of naval values by the ranking of surface fighting vessels as secondary to big undersea craft yet to come. In short, the future has in store the submersible battleship.

Germany set the pace. Her ripe experience in construction and operation produced her cruising submarines, a small fleet of eight boats, built in 1918. They were of 2,700 tonnage, had a surface speed of 18 knots, and a radius of 20,000 miles. Their armament included six-inch guns; the crews numbered more than 100. In equipment, Germany, by the war's end, had also developed a number of high-speed Diesel engines of 3,000 shaft horse power. She only succeeded in using these engines in a couple of her cruising submarines just before the Armistice.

Since then the naval countries, including the United States, have not stood still. Both in high-powered engines and in gunnery they are advancing at the pace Germany set. The British K type, with steam turbines, were experimentally installed with Diesel engines of a higher power than Germany produced. Their success would result in an undersea fleet with a tremendous range, especially as Great Britain has 12-inch guns on some of her submarines, built for attacking land forts. Her K boats carry eight 18-inch torpedo tubes and a 4-inch and 3-inch gun. They have a submerged displacement of 2,650 tons, a speed of 24 knots, and are 334 feet long.

Japan is credited with having building plans for sixty new boats, and there is little doubt that she will eventually produce craft of large tonnage.[1] One of her big submersibles, ac-

[1] Reports in the summer of 1922 that Japan was evading the Washington naval treaty by augmenting her tonnage of auxiliary vessels brought an Admiralty statement from Tokio that her present plans embraced only twenty-four new submarines with an aggregate tonnage of 28,166.

cording to *Motorship,* will have three two-cycle Diesel engines of 4,000 shaft horse power. This drive indicates, it is added, a boat displacing some 2,200 tons on the surface, 350 feet long, and a speed of 23 to 25 knots, and that such a vessel could carry ten 18-inch torpedo tubes, a 6-inch gun and two 4-inch guns, as well as anti-aircraft armament. Japan's use of powerful electric-drive engines of the Diesel type conveys the scope and range of her future submarine fleet.

What of the United States? The naval appropriation bill of 1922 provided for the completion of forty-two submarines under construction, for which some $19,000,000 was available. The building program included three boats of the V class, a type larger and more powerful than any submarine the navy has had in service, but, nevertheless, of lower grade as fighting craft than many existing foreign boats. Their tonnage slightly exceeds 2,000, and they have a length of 300 feet, a speed of 21 knots, and a maximum brake horse power of 7,000. They also are to be equipped with Diesel electric-drive engines. For armament they have one 5-inch gun, a machine gun, and six torpedo tubes. The V class are of a design adaptable to great ex-

SUBMARINES IN WET DOCK, FORE RIVER, 1914

pansion in power and size, and the navy hopes to profit by the experience gained from their operation in the construction of future boats. But neither the available funds nor present naval plans permit of this development. The three boats can be completed as designed under existing appropriations, and additional craft must await further funds from an indifferent Congress.

The post-war period has produced—so far on paper—a 7,000-ton submersible, designed by Professor Oswald Flamm, constructor of the German commercial submarine *Deutschland.* Germany is barred from building any U-boats for decades to come, and the Flamm boat is, therefore, of no use to her. Its contemplated radius of action is put at 23,000 miles, or approximately four round trips between the United States and the North Sea without touching any port. Its projected armament is two 8-inch and four 3½-inch guns, with 5,000 rounds of ammunition, and eight torpedo tubes with forty torpedoes. The designer predicted, not without ground, that if Japan secured his design she could, in case of war with the United States, utilize several of such submersibles to cut off the Pacific from the Atlantic fleet by destroying the entrance to the Panama Canal. A Berlin report had it that Professor Flamm would rather sell his invention to the United States than to any other country, but that Japan and Great Britain had been pressing him to turn over the plans to them, while the United States had "shown only a mild interest" in the boat. There was a reason.

The 7,000-ton submarine, in the present condition of naval exchequers, is a long way off practical realization. It approaches the restriction in the size of auxiliary craft (10,000 tons) named by the Naval Limitation Treaty, but only the five powers signatory to that covenant are governed by it. Other nations can develop their auxiliary craft as they choose without hindrance. Possibly the submersible battleship, which the Flamm design foreshadows, may come from them, in view of the restraints in expansion the five leading powers have imposed on their navies. In any event, the development of submarines points clearly enough to the eventual emergence of great fighting ships which can disappear under water to escape surface attack when at a disadvantage. The bombing airship, which has developed step by step with the submarine, has already opened a vista picturing huge war-craft seeking the protection of submergence. Certainly the airship and the submarine have alike impaired the fighting value of battleships on the surface.

Our own Navy Department is not unmindful of the outlook. Its construction experts are credited with taking a long look into the hazy future by devising tentative plans for a 20,000-ton submarine. This would mean a craft equal to the combined tonnage of the old battleships *Massachusetts* and *Iowa,* with a strong armament for both surface and submerged operations. It is thus a conception of a submersible battleship. The existence of such plans, as implying a practicable project, is not admitted, and the report is here recorded with due circumspection.

The prospect of such a boat ever being built on plans as conceived to-day is remote. Such an innovation, in the Navy Department's view, lies so far in the future and is so liable to change and development that nothing can yet be said about it. Still, it is of moment to the chronicler. That such plans should be formulated at all shows the direction which constructive ideas in the field of submarine development are taking. They have a significance for that reason alone, especially as the actual prospects of expansion in cruising submarines point to such an eventual growth of the type. Even Italy, which cannot be deemed a dangerous foe in her present submarine power, is looking ahead in the same direction with plans for building four classes of large submarines, varying from 21,000 tons, 24,000 h. p. and 16 knots speed, to 22,000 tons, 18,500 h. p. and 20 knots. So the United States is not alone in its foresight. The decade covered by the Naval Limitation Treaty expires in 1932. Much may happen meantime; much will surely happen in naval policy thereafter.

CHAPTER XXIV

The submarine situation wide open.—All countries free to build them.—The case for smaller nations.—Submarine strength of leading navies.—Conflict over allotting tonnage proportionate to capital ships.—France's objection to being rated below the United States and Great Britain.—British action if France builds big submarine fleet.—A race for supremacy inevitable.—Outlook for another conference curbing increase of under-water craft.—Probable reaction on American naval policy.—Scheme for adequately guarding our coasts by submarine fleets at temporary bases.—Fixed defenses ineffective without submersibles.—Need of hundreds of such boats.—Economy of submarine defense.—Popular indifference to naval needs.

FINAL considerations turn to a further study of the maritime issues presented before the Conference for the Limitation of Naval Armament. That assemblage left the submarine situation wide open. It was an explosive subject. Drawn together to limit armaments, the delegates departed from their agenda by advancing weighty arguments showing the imperative need of extensive undersea fleets in view of the curtailment of capital ships. Secretary Hughes mildly protested against the course they were taking. He reminded them that it was not a conference to increase armaments. Nevertheless, the case for the abolition of the submarine was adroitly utilized by

M. Sarraut, speaking for France, to show that the conference could not control their limitation, and that the powers faced the necessity of continuing to build them.

What of other nations, he asked, who were not represented at the conference? Were they, or at least those who possessed submarines, desirous of abolishing them? Any decision of the Conference to end undersea craft would apply only to the five leading powers which made it. Would the other nations submit and follow their example? What would happen if these nonrepresented countries continued to build submarines, either for their own or for some other government's use? What sort of a situation would face the powers who relinquished submarines if, peradventure, war were to come again? They might be confronted with great submarine forces constructed outside the five-power group. Countries not able to afford big fleets would naturally reserve to themselves the right to build undersea craft. They had no other choice when they beheld greater nations maintain powerful surface armadas. A decision to abolish submarines would therefore have to await the adherence of other nations—and they would not get it.

The case against the abolition of submarines was insurmountable, as indicated in the first chapter. It introduced elements which forced the recognition that their retention was inevitable. Restrictions on their use were readily enough forthcoming, this being the one submarine issue on which the Conference found no inherent difficulty in reaching unanimity.

Thus was the ground laid for further contention. Submarines had come to stay and could not be ousted; but they must not be wrongly used. What, then, should each nation have?

The submarine tonnage, built and building, of the leading navies at the close of 1921, stood as under:

United States	95,000	tons
Great Britain	82,464	"
France	31,391	"
Japan	31,452	"
Italy	21,000	"

The first proposal to limit the building of submarines, based on a ratio to fighting surface fleets, was to allot 90,000 tons each to the United States and Great Britain, the ratio for France, Japan and Italy to be what submarine tonnage they already possessed. This meant that the United States reduced its tonnage by

5,000, Great Britain increased hers by about 7,500 tons, and the other three countries could not add to their existing undersea fleets.

France held out strenuously for the proportion the United States and Great Britain would receive, namely, 90,000 tons. Japan wanted 54,000 tons, but was not disposed to insist on any increase if France accepted the *status quo*. Italy sought to be on a parity with France, whatever irreducible minimum the latter country could be prevailed on to accept.

France was the stormy petrel of the Conference on the submarine issue. Secretary Hughes pictured the situation should her demand for 90,000 tons be acceded to by the Conference. Submarines, if they were to be available for distinctly defensive purposes in connection with the movements of fighting fleets, should bear some definite proportion to such fleets. Used for laying mines, scouting, etc., their work should have a relation to the operations of the fleet as a whole. If France's fleet of 175,000 tons required a submarine tonnage of 90,000 to scout for and protect it, how much more submarine power would the United States and Great Britain need to assist their respective fleets of 500,000? Secretary Hughes told the Conference that allowing

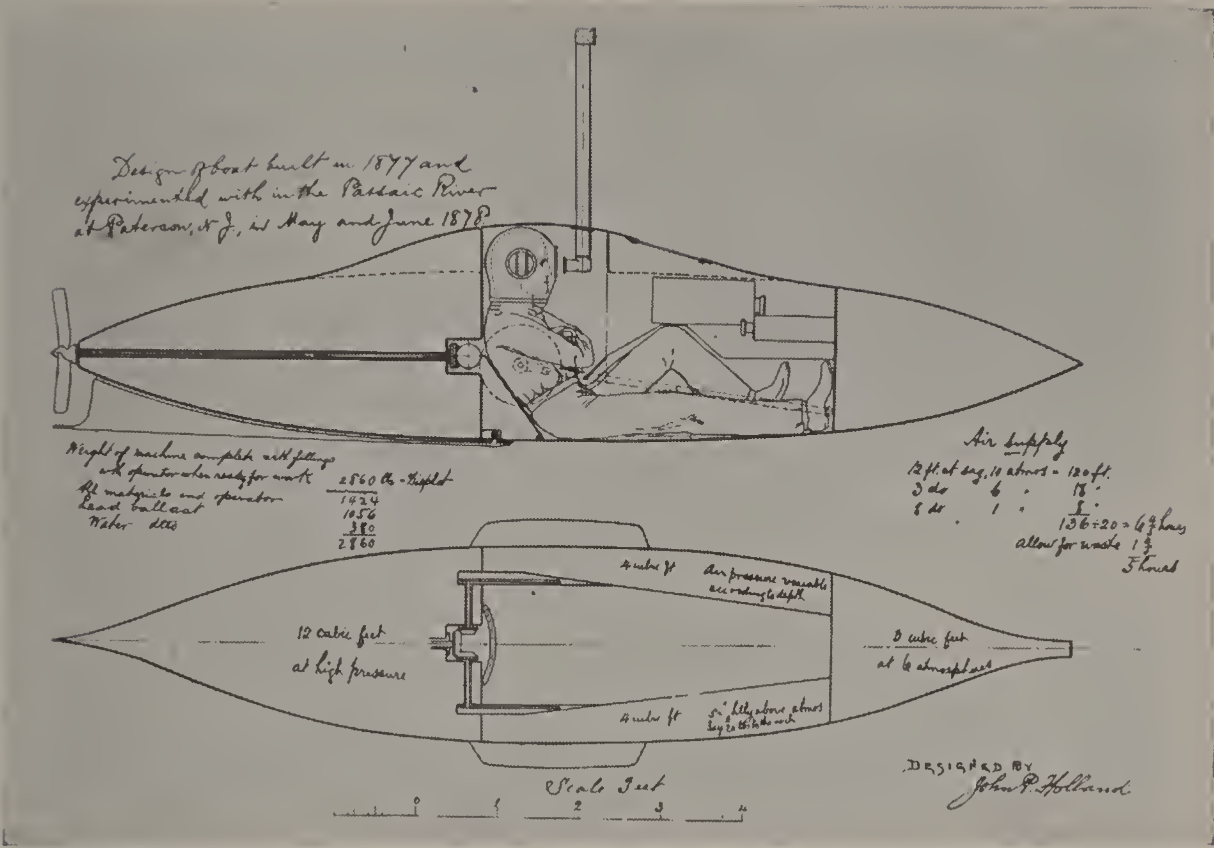
France such a tonnage would, on the basis of a practicable ratio to her fighting ships, involve the necessity of the United States and Great Britain greatly augmenting their undersea fleets to make their ratio conform to France's. Hence an allotment to France of 90,000 tons reversed the intent of the Conference; it meant a big increase, not a limitation or reduction.

Further, increased submarine fleets predicated the provision in numbers of light craft and destroyers, the natural foes of submarines. In this direction Lord Balfour warned the Conference that if Great Britain had at her gates a fleet of submarines aggregating 90,000 tons, 60,000 of which necessarily would be of the newest type, she would reserve fullest freedom of action. No limitation in the building of auxiliary vessels for attacking submarines would be recognized by any British government.

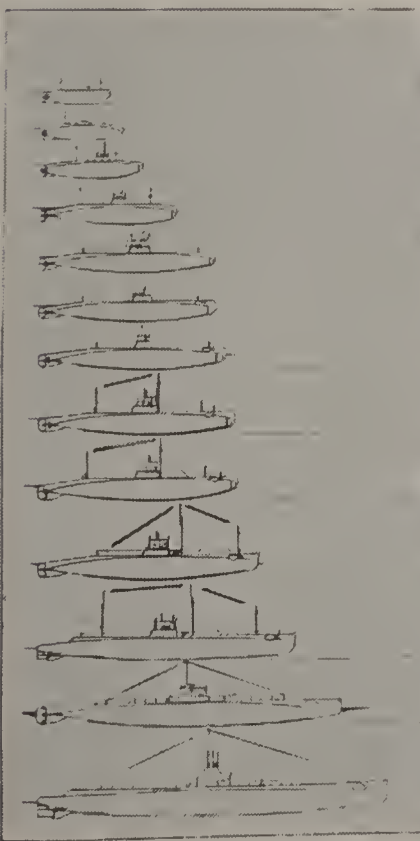
The next proposal was that the United States and Great Britain would be content with 60,000 tons and that Japan be allotted 36,500, France 35,500, and Italy the same as France. But again France insisted on a parity with the two leading navies; if they received 60,000 tons, so must she. She objected to being in either second or third place. Her spokesmen protested that her attitude was not due to fear of neighbors. She had long coast lines and a great colonial empire, second to Great Britain's, distributed all over the seas, and was concerned solely about its defense, policing and surveillance. Her colonial empire, though many were ignorant of it, really existed, and must be protected, especially in safeguarding communications with the mother country.

The outcome was that the Conference could not agree to a limitation of submarine tonnage. A country could build what submarines it pleased until the time was ripe to call another conference to reconsider the subject. The situation presented the prospect that if France, of her own volition, determined to get into line with the United States and Great Britain as a submarine power, her action would signalize a race in the building of great undersea fleets and opposing craft.

The Conference wranglings emphasized what was clear enough all along. Every naval nation, barring Great Britain, wanted more submarines, by international agreement if possible, and, otherwise, to the extent of their financial means. And Great Britain, accepting the situation after being balked in her plan to abolish such craft, would herself be in the



BOAT DESIGNED AND BUILT BY JOHN P. HOLLAND IN 1877 AND EXPERIMENTED WITH IN THE PASSAIC RIVER



DATE OF DESIGN	LENGTH OVERALL	DISPLACEMENT SUBMERGED	SURFACE SPEED	MAXIMUM SPEED SUBMERGED	RADIUS AT CRUISING SPEED	HORSE POWER ON SURFACE	HORSE POWER SUBMERGED	ADDED FEATURES OVER PREVIOUS DESIGNS	NUMBER OF TORPEDO TUBES
1895	53'-3"	73 TONS	6	5	200	50	75	DYNAMITE GUN (AFTERWARDS REMOVED)	1
1900	64'-0"	122 "	8	7	490	160	105	LARGER TORPEDO TUBE	1
1905	82'-5"	170 "	8¾	8	850	250	150	ONE PERISCOPE	1
1907	105'-3"	273 "	10½	9	900	500	300	TWIN SCREW & SUBMARINE BELL	2
1907	134'-10"	337 "	13	9½	1240	600	330	BULKHEADS 2ND PERISCOPE & CRUISING BRIDGE	4
1909	135'-3"	340 "	13½	11	2475	550	520	HEAVY OIL ENGINES & BOW RUDDERS	4
1909	144'-2"	400 "	14	11¼	2350	780	620	INCREASED SPEED, SURFACE & SUBMERGED	4
1910	147'-3"	434 "	14	10½	2300	900	620	LARGE CONNING TOWER WIRELESS & DECK ANCHOR	4
1911	153'-6"	480 "	14	10½	3150	900	680	FOUR SPARE TORPEDOES & GREATER RADIUS	4
1913	167'-5"	548 "	14½	10½	5500	900	680	ONE 3" GUN & STRONG BULKHEADS	4
1915	196'-3"	675 "	15	10	7000	1200	680	DOUBLE HULL CONSTRUCTION & HEAVY DUTY ENGINES	4
1918	219'-3"	1064 "	15½	12	10000	1300	1500	ONE 4" GUN - LARGER TORPEDOES 8 SPARE TORPEDOES CARRIED	4
1919	269'-9"	1484 "	21	11½	12000	4000	1500	ONE 4" GUN & TWIN DECK TORPEDO TUBES	6

SKETCH SHOWING PROGRESS MADE IN THE DESIGN AND CONSTRUCTION OF SUBMARINES FROM 1895 TO 1919

forefront in expanding her undersea fleet if France ventured to set the pace. Always far-seeing in her naval policy, Great Britain was bound to give thought to the possibility of another submarine blockade of her coasts, in view of the outlook for an unrestricted scramble for submarine supremacy. British observers even foresaw her future need of an undersea commercial fleet of boats of 3,000 to 6,000 tons displacement to insure the transportation of food and materials to her ports should her coasts be again blocked by another nation's submarines. There was, in short, no end to the potentialities of naval development outside the functions of capital ships of maritime nations elected to make the submarine their chief reliance.

What is abundantly plain at the present stage is that Great Britain would never agree to France's submarine tonnage equaling hers, and her stand was supported by the United States. Both held that France's allotment should be in proportion to her fighting-ship tonnage.

A vague prospect held out for the holding of another conference to settle the issue did not ease the situation. It is true that the shadow of an agreement at a second parley might promote a tendency to deter submarine building for fear the new boats would eventually be scrapped, like the superfluous capital ships named in the Naval Limitation Treaty. But if the outlook for a second conference was regarded seriously—which is doubtful—its future assembling rather points to a stimulus in the construction of new submarine craft. Naval nations would thus be able to present a better *status quo*. The more boats they had, the less would their strength be weakened by a pro-rata reduction.

A race for submarine superiority in Europe would react upon the naval policy of the United States. But our course should not await foreign initiative springing from international rivalries. What we do should be determined by our immediate needs, not by what other nations elect to do in a contest of submarine building.

Our unprotected coasts point to a duty undone. Their fixed defenses are almost valueless against modern armaments. Suppose they were reinforced. The organization of a complete manning force to guard our coasts adequately, even without any provision or relief details to replace casualties, would demand an enormous standing army at a prohibitive cost.

Provision for efficient relief would add to the cost. Artillerymen, unlike infantrymen, cannot be trained in a short time; they are a corps of experts subject to long periods of preparation and practice. Under these circumstances it is futile to suppose that the fixed defenses of the United States could ever be adequately equipped to meet the sudden demands of war. They must, therefore, be supplemented by floating defenses.

We should have a navy of sufficient size to protect every foot of our coast lines at a moment's notice. They are our future coast defenses.

Fixed defenses need not be abolished. Submarines in sufficient number, and adequately manned and equipped, would serve as invaluable auxiliaries to them. Moreover, they would give far greater security than would an extension of fixed defenses at the same cost.

The mobility of the submarine enables it to be transferred from one base to another as the occasion for defense may arise, and when such necessity at one point disappears, the boats can be removed to other points. This mobility is of the utmost service in connection with temporary defense bases in our island dependencies and elsewhere, since such defenses at these points can be effected without the outlay required for permanent defenses, a large part of which is lost when the base is abandoned. Aside from the question of cost, the rapidity with which temporary defenses can be organized is of vital importance.

If Congress to-day were to recognize the situation and provide enough submarines to effect a complete defense of the United States and its dependencies at all times, the question would arise as to the method of procedure, and the type, size, and number of boats necessary.

The protection of our Atlantic coast from Maine to the Florida keys, a distance of nearly 2,000 miles, would require a minimum of 200 submarines of our latest designs. The types for this service would be, in my opinion, those of the S and V classes now building. To repel foreign invasion these boats could form a double line the entire length of the coast if necessary, and operate several hundred miles out at sea. They could be quickly massed at any one point, if such a concentration were necessary. Their commanders, in constant touch with airplanes on scout duty, would know the exact location and number of hostile ships at any time. Probably half this fleet of 200 boats would suffice on the firing line. The remaining half could be held in reserve.

Numerous shore bases would have to be provided at suitable points where the boats could be supplied, overhauled, and kept in condition. In addition, the boats could be divided into flotillas, each flotilla provided with a submarine mother ship, so that in emergencies the actual fighting units could be kept on the firing line for days at a time and supplied by the mother ships, which would carry necessary stores, repairing outfits, and relief crews.

The use of submarine mother ships, as far as I know, has never been developed. Their service is quite practical and merits serious study, particularly for the undersea protection of our west coast and island possessions. If one of our modern submarines were to travel several thousand miles to provide protection at some point, at the end of the trip she would have to return to her base for supplies. With a supply ship at hand she would save much lost motion.

The conditions of submarine protection for our Atlantic seaboard apply to our coast lines everywhere. Providing enough submarines to carry out the plan of defense outlined for all our coasts would require the construction of several hundred boats. The question would then arise, how can we most economically keep them in condition in peace times? This should not be difficult. Three-fourths of the fleet would be tied up and divided into flotillas, each flotilla in command of a competent submarine officer. He in turn would have under him enough submarine experts to keep the boats in efficient condition to guard against deterioration. The number of men needed in each flotilla would be comparatively small.

The remaining fourth of the fleet would be kept in commission and actually operated a few hours each week. This would keep a certain number of men in constant training and ready for an emergency. Periodically the boats in commission could be tied up and replaced by a new group. In this way the whole submarine fleet could be kept seaworthy. In case of need we would have enough experts to man the fleet and every boat without much delay could operate with the highest efficiency.

On active service, under war conditions, a submarine requires only a few experts. With these technicians a full crew could be assembled from civilians and men from the mercantile marine.

If some of our technical experts would compute the cost of submarine protection as thus outlined, and compare the figures with the cost of the same protection from shore defenses, battleships, cruisers, destroyers, supply ships, etc., I believe the result would be so overwhelmingly in favor of submarines that Congress would not hesitate to appropriate the funds needed.

This plan is not the result of technical study, nor is it a scheme from the brain of a visionary inventor. It is the fruit of twenty-five years' experience gained in practical submarine work in every part of the world, and under every condition met with in undersea navigation, as well as of careful observation and frequent contact with other submarine technicians.

For good or ill, the submarine, with its unlimited potentialities of growth as a war weapon, is fated to become the backbone of navies. In undersea craft lies our future naval development. Unfortunately, one serious aftermath of the World War is the growth of an indifference to our navy. National interest in it has become more than ever lacking since the four leading powers agreed upon a limitation of capital ships.

We ought not to forget the lessons learned in years past. The folly of unpreparedness has cost our nation many billions of hard-earned dollars, and taxpayers will be mulcted for many years to pay the price of this short-sighted policy. Had we taken advantage of the knowledge gained from the Spanish-American War of 1898, we would have been prepared for the battles we were to fight in 1917.

When the war with Spain ended, many of our substantial citizens settled back in the old rut and prophesied that we had fought our last war. The Hague Peace Conference promised us this, and most of us believed it. To-day our Congress likewise believes that we have fought our last war and that an army and navy of any size is needless. The Secretaries of the Navy and of War have vainly recommended the maintenance of an adequate military force to protect the coasts of the United States. They have been supported by General Pershing and other army leaders who have seen their comrades fall in thousands on European battlefields. If these fallen heroes could speak they would tell us that preparedness would have saved many of them.

The time is coming when our people will heed the lessons learned in the World War, for which we paid such a tremendous price. It is hard to believe that they will let false ideas of economy deter them from recognizing our military needs. The drastic reduction of our army by Congress will leave us with hardly enough men to police the country in case of trouble, much less repel a foreign invasion.

Our depleted navy is in a like plight. Reinforced by ample submarines, its added strength would equal the loss it suffered by its sacrifice of capital ships. If we do not add materially to our undersea fleet we will be jeopardizing the security of every American citizen.

The Conference for the Limitation of Naval Armament will have done this country a doubtful service, not to say unmeasured harm, should its limitation of capital ships lull our people into a mistaken sense of security and cause them to disregard their duty to our first line of defense. The effect of such apathy and indifference is at once reflected in a supine Congress. Our navy is in danger of degeneration if our people forget that it still exists for our protection and fail to demand national recognition of its needs.

Supplementary Chapter

By

W. W. Kimball,

Rear Admiral, U. S. N., Retired

In reading Captain Cable's excellent book, I am impressed by his fairness in giving Holland the credit he deserves and as he deserves it.

My own friendship for Holland began in 1883 and continued until his death.

In the early 'eighties, I became interested in the submarine question, had seen the design of a one man-power boat that Holland submitted to the Torpedo Station—there was no Naval War College then, nor for some years thereafter—and knew in a general way what he had accomplished in the *Fenian Ram*.

Holland came aboard the flagship of the N. A. Station, then alongside the dock in the Brooklyn Navy Yard, to dine in response to my invitation, and after dinner we went over the main principles of his methods for the control and maneuvering of a submerged craft.

At that time the more general way of working a submerged craft in the vertical plane was the method of varying the specific gravity of the boat, i. e., when it was desired to submerge, water ballast was taken in until the boat was slightly heavier than water and she sank below the surface; when it was desired to rise, water was pumped out until she was lighter than water. While she was of about the same weight as water, she could be given motion of translation by her propeller.

This was the system applied to the French submarine *Plongeur*. Diving rudders were not used. The result was that the craft dropped to the bottom, bounced from there to the surface, and was practically out of control in the vertical plane.

Holland held that a submarine should always be lighter than water, should retain what we agreed to call "normal buoyancy," so that if any accident happened to her mechanism she would rise and not sink, should have as nearly as possible an immovable center of gravity—this to be accomplished by taking in a weight of water equal to the weight of any article removed (as when a torpedo was discharged), with the center of gravity as nearly as practical coinciding with that of the article removed; should be steered down, taking down the normal buoyancy under the action of her diving rudders and the push of her propeller.

These three requirements—normal buoyancy, immovable center of gravity, and control in the vertical plane—comprise the basis of what years after became known as the Holland type of submarines. Of course, we discussed many details; as how to get the requisite low but safe meta-centric fore-and-aft height, so as to make the craft handy on her vertical helm and at the same time stable enough to be safe, and many others.

To-day, Holland's three main principles are very simple, very apparent. They were not so in 1883.

Before going to sea on the cruise during which I had Holland as a guest at dinner, I had given the submarine question a little fillip in the Navy Department and Lieutenant F. M. Barber had published an Ordnance pamphlet on the matter, a pamphlet in which, among other submarine boat designs, Holland's one-man boat was shown.

At the time Holland was my dinner guest, the Fenian Ram had been surreptitiously taken from him and he was working at Rowlands in developing explosive engines with Brayton. He was most anxious to return to submarine construction.

Before he left the ship he had agreed that, if I could arrange it, he would work on a draftsman's pay, in the Bureau of Ordnance, on his designs. The Bureau was to indicate the torpedo requirements, of which Holland was entirely ignorant, and he was to see how he could work them in. He was to make a cast-iron contract with the Department to receive, if his designs proved practical and were adopted, such compensation as a board of officers, appointed by the Department, should find fair and just, in view of the fact that all expenses of development were to be borne by the government.

If the Department chose to hold the designs and inventions secret, the compensation was to be greater than it would be if Holland was to be free to market his invention outside the Department. Holland was delighted with such a prospect. He wished to be of use to the government and felt that he would get fair treatment, fair compensation, and would be spared the risk that all inventors run of being squeezed out of his fair show of profits when inventions are developed by private capital.

The Chief of Bureau of Ordnance was much inclined to make the offer as I had arranged, but Congress had adjourned. There was absolutely no money available to pay Holland as a draftsman. Had there been, Uncle Sam would have been saved many millions and would have held the Holland type of submarines, as his private property for many years. However, there was a hope that the matter might be arranged.

Holland waited. I was bound away to the southward. Just before sailing, Zalinski came to me and asked who knew anything about submarines. I told him that Holland was far and away the best submarine man in the United States, if not in the world, but that he, Zalinski, was to keep hands off, as the Navy Department might make Holland an offer. Zalinski told me that some men with money wished to build a submarine and arm her with Zalinski's guns. I assured him that a submarine with torpedo armament was nonsense and that, anyway, the Franco-Chinese War, toward which his money men were evidently looking, would be over long before a submarine boat could be built and launched. Two or three months later, while cruising down the Spanish Main, came a letter from Holland saying he had waited as long as he could for the Navy Department; that he would much prefer working on a draftsman's pay for the Department under proposed condition, to the thousand-dollars-a-month salary as president of a building company, offered him for some time back; that necessary support for his family would not allow a longer wait—and so he had gone to work for Zalinski's company.

The following season, when my ship touched in at New York, I ran down to Fort La Fayette, where the Zalinski company boat was being built, to see Holland and have a chat. There was much mystery and secrecy at the fort. A canvas screen prevented people from seeing what was in building. Zalinski was glad to have me overhaul the boat and assured me that the screen was simply a defense against the news-reporter nuisance. Holland appeared from the bowels of the wooden spindle-of-revolution shaped craft on ways in the fort. His face was smudged and his brow careworn.

He confided to me that all that could be proved by the craft was that atmospheric air at normal pressure and at normal purity could be breathed by humans in a boat under water just as it could in a room above water; that she had no practical propulsive power and no real armament; but that the men furnishing the money required the air-breathing test.

Before the boat was launched the Franco-Chinese war was over, and when she left the almost impossible launching ways from the terrain of the fort to the water, she was stove and sunk. There was absolutely no submarine information obtained from her construction. The company that built her faded away.

At the end of my cruise, which had been prolonged beyond the usual term because a report to Congress on the progress of the work on the Panama Canal was required to be made by me, I found myself, in the latter part of 1886, on duty in the Bureau of Ordnance, where lay construction of all torpedo craft, and not in the Bureau of Construction, where it was placed later. The submarine question was troublesome. Three or four tentative designs had been offered to the Department. Nordenfeldt was building submarines for Turkey. The French were experimenting. Mr. Whitney, the Secretary of the Navy, was strong on asking bids for all kinds of naval construction and supplies.

I suggested that an easy way to meet the submarine bother was to ask for bids for furnishing a submarine just as bids were asked for furnishing shoes or canvas. This was considered revolutionary and impracticable because no one could draw specifications showing the requirements of the Department to be met, for a useful submarine torpedo boat.

I agreed to draw such specifications subject to approval by the Chief of Ordnance.

In drawing the specifications, there was a hard struggle over requiring the boat to be able to remain still, with propeller not turning, at any predetermined depth. I held that this feature was not necessary, since the boat could be held very near any place at any safe depth by keeping merely steerage way and moving in a circle; that if her power was to be cut off and she were allowed to give up her normal buoyancy, she could be balanced within a few feet of a desired depth; that if normal buoyancy must be maintained and moving power cut off, then the only way was to install down-haul propellers and engines, which would complicate matters sadly. However, the chief was very strong for the ability to remain at rest at a desired depth and not on the bottom, and so this feature went into the specifications. It proved to be a troublesome thing in later years.

Only two designs were offered, both by the same company—the Cramps, shipbuilders. The designs were those of Holland and Nordenfeldt.

An amusing circumstance was that in their bid the Cramps put in Holland's description of the ease, certainty, and safety with which a submarine could be handled, and then explained the high price they set by accentuating the danger to their personnel in making trials.

I said to Charley Cramp: "You seem to wish to grab all submarines. You want the earth."

He replied: "Not at all. We want the sea only, and all that goes into it."

The Naval Board found in favor of the Holland design, but rejected the bids as exorbitant in price. It was suggested that the Cramps be asked to build the boat at a good shop profit and that the dangerous trials be made by navy personnel; but Mr. Whitney was very strong for requiring bidders to prove that their goods were as specified, and so the matter dropped with a recommendation by the board that new bids be asked for.

With the change in administration, interest in submarine development languished. Correspondence with Holland indicated a gloomy outlook.

However, another competition in designs was held, which Holland won, and an appropriation of $200,000 made for the construction of a submarine boat if the Department desired to have one constructed, which it very decidedly did not.

At the end of my next cruise at sea, Holland came to me, quite cheerful. He had formed a company, his design had won a third competition, an appropriation of $150,000 had been made, and a building contract was in the making. I met Holland's backers and found them to be a prominent estate trust lawyer and a cemetery owner and developer. I asked them why, in the name of common sense, were they going in for submarines when all of us who believed in them were considered to be pestiferous cranks. They told me that they indulged in invention flyers now and again and were much impressed by Holland's directness and apparent knowledge of the matter in hand.

Holland's accepted design had to be from the nature of the case, a sketch design showing applications of principles and methods of working, but not working-drawing dimensions, since even the dimensions were not fully decided upon.

Under such circumstances the contract very properly required that the details of the working drawings should be approved by the Department.

The power for this boat, the ill-fated *Plunger,* was to be steam, the submerged running to be made from the pressure remaining in the boiler after the closing of the furnaces as the boat went under. The method was most unsatisfactory, but was adopted by Holland as the best thing then in sight, and a method that had given quite remarkable results abroad. Before the boat was launched, electricity was used for auxiliary power and submerged work.

The steam boiler was a serious handicap, but not altogether inadmissible, as were Departmental requirements as to approval of details. Because the foolish requirement in regard to maintaining a desired depth when at rest had been printed in the first specifications years before, it had all the sanctity of things decided upon and so went into the *Plunger* contract. This necessitated two propellers mounted in sleeves, one forward and the other aft, and two engines to operate them in hauling her down against her normal buoyancy. They were distressing things to contemplate. At that time twin propellers were replacing single screws in surface craft, and "Condor" Charley Beresford in England had set the fashion of twin-torpedo tubes on surface torpedo-boat decks.

When Holland asked the Bureau of Steam Engineering what propulsion would be approved for the *Plunger,* he was told that twin screws must be installed, whatever else. He explained that he had to have a propeller in the axis of the spindle-of-revolution shaped boat to push her under and to push her up, and if compelled to install twin screws in addition with their engines, that there would be great and unnecessary complications. He was told that

that was a matter for him to meet, but that she must have twin propellers.

Then he asked the Bureau of Ordnance what torpedo-tube installation would be approved. He was informed that two torpedo tubes were required. He explained that putting in a single tube was difficult in view of the shape of the bow, and that two eighteen-inch tubes would destroy her bow lines. Twin tubes were declared to be absolutely necessary. So Holland sorrowfully went to work to get those requirements into his working plans.

A short time after these requirements were made, I met the director of Holland's company and told him that in my opinion the *Plunger* had been made an utter failure. She should have, for the sake of the simplicity so necessary in all untried mechanisms, one propeller and one engine. She was required to have five propellers and five engines. She should have one torpedo tube, or better none at all, until the underwater control had been proved out; she had to have two. She could not possibly function with all that complication aboard and would better be given up.

I expressed the opinion that the only practical thing to do, provided the company had the necessary pluck and the more necessary money, was to build a boat of their own and demonstrate what she could do. Holland agreed with me as to the necessity for private construction, but thought that there would be enough information obtained from the *Plunger* in underwater work to warrant continuing work on her. He asked me to lend a hand in designing, especially as to military features, which I agreed to do, and the company decided to build a boat of their own at Nixon's yard, knowing that Nixon would keep the cost down as low as possible. So the building of the *Holland* was decided upon. Storage batteries had been developed far enough to indicate electric drive for submerged work. A lot of contrivances were devised which were never used.

The question of holding a course at a premeditated depth was unsolved, and therefore an automatic arrangement for steering in the vertical plane on the principle of that used in torpedoes was worked out. The bugaboo of ventilation was met by managing to keep the boat constantly ventilated at normal air pressure. This consisted of a delicate reducing valve on a compressed-air flask and a small electric-driven pump for pumping air out of the boat. When the craft submerged, the pump automatically started. When the air pressure fell below normal, corresponding to the pressure to raise water one inch, a pet cock on the compressed air opened and through the reducing valve air at normal pressure flowed into the boat and the exhaust pump was stopped. When under supply of air from the flask, the air pressure in the boat was raised above normal, the air supply from the flask was cut off, and the exhaust pump started. In this way ventilation at normal air pressure was to be secured.

Neither of these devices was used, for the reason that, as Captain Cable shows, there was no difficulty about steering by hand, in the vertical plane, and no trouble about air supply for breathing.

Before the *Holland* was off the stocks the war with Spain was looming—all the causes of that war were as exigent in the fall of 1886 as they were later—and I was very anxious to have an air gun installed for use in dropping high explosive shells into the Morro at Havana. We did not know how to use high explosives with gunpowder propulsion in those days. The air gun was not very much in the way in the boat, and so it was installed.

As the building of the *Holland* progressed, I kept the run of things by visiting Nixon's yard now and again until my time for sea service came around, and in the spring of 1897 I sailed in command of our first torpedo-boat flotilla.

Touching in at New York after the Spanish War, I found Holland and Captain Cable trying out the *Holland* in New York Harbor as described by Captain Cable. The Holland company was at the end of its tether financially and were negotiating with Mr. Rice for necessary capital. Mr. Rice asked me what chance there was for the future of submarines. I told him that the Navy Department was opposed to them, that Great Britain in her own interests was bound to hold them back, but that every navy would have to have them eventually, especially small navies; that I knew nothing about money, as I never had any, but if he wanted to take a long chance, it seemed to me that a dip into submarines was a good gamble.

He decided to finance the company. The *Holland* demonstrated her capabilities. The Navy Department took less interest in her than none at all.

Before sailing on a surveying job in Nicaragua, I told Mr. E. B. Frost, who bore all the heat and burden of the financial end of the Holland boat's development, that the thing to do was to ask the Department to define the requirements of a practical submarine torpedo boat, then to practice with the *Holland* till meeting those requirements would be certain, then to ask for a trial board, the favorable report of which would give the submarine a real status.

Mr. Frost said: "Good Lord! If we ask what the boat should do, they will tell us she must climb a tree!" However, the requirements were asked and the Department made such that, at home and abroad, they were considered quite impossible of fulfillment. I happened to know who made the requirements and why they were made. In requiring what was considered to be an impossibility in submerged running and in holding an under-water course with the difficulties arising from unreliable compass indications, the real test of a submarine in offshore work, which would have been most difficult for the *Holland,* was entirely neglected.

Holland was confident that his boat could meet the tests. I told him to pick out a place where the water was not so deep but that the crew could come up if the boat broke down and sank, and have her do the requirements again and again before asking for the official trial.

There were plenty of places up Gardner's

Bay that, in my opinion, would answer for practice courses. Peconic Bay was selected and the practices held as Captain Cable describes.

The official trial resulted in a report from a board of officers of the highest professional standing—Captains F. Rodgers and R. D. Evans were on the board—that the *Holland* had met all the Department's requirements for an efficient submarine torpedo boat.

She had. She had made what had been considered an impossible submerged run. She had not been called upon to show what she could do in offshore service.

When my cruise was up early in 1900, I found myself on shore duty at the Washington Navy Yard.

Frost came to me and said: "Under your advice we asked for requirements. It took a pretty penny to meet them. You told me that an official report would give us a status. We must have the approval of our own country in the shape of an order for boats before we can do business. We have the finest report whatever. We have the status you talked about, but we don't get any indications that we will ever get any orders for boats from the navy. The Department is as much down on us as ever. Our business is building and selling boats. We are going to send the *Holland* to Washington and make her lobby for an appropriation from Congress."

I was forced to acknowledge that the logic of events seemed to prove that my advice was not so very valuable, but that, after all, a status was a status.

Captain Cable has graphically described the trials and tribulations connected with the *Holland's* work in the Potomac.

Meantime the Holland Company had asked Congress for an appropriation for submarines.

Hearings were held by the Naval Committees of both Houses. Holland, under examination, told his story to the Senate Naval Committee. Three chiefs of the bureaus having to do with construction controverted Holland's statements and showed that submarines when not death traps, were toys, and that they were to be carefully avoided. The committee called me before it. When a congressional committee calls on naval officers, the Department directs them to express their opinions if asked for them. I expressed mine. They ran directly counter to most of those of the three chiefs of bureaus who had given theirs, and the committee was most polite in expressing interest in my statements. Seven boats were appropriated for by Congress, boats which were neither asked for nor desired by the Department.

As a junior commander in the navy, controverting the opinions of my superiors before the Senate Naval Committee flattered my egoism and was most amusing and interesting, but it was far from the course of wisdom in pursuing a naval career.

During the working out of the constructional details of the seven boats of the *Adder* class by the company's staff, Holland was ill and unable to give them his personal supervision. The consequence was that errors crept in militating against the efficiency of the craft, errors that Captain Cable had to meet and correct as he shows in his narrative.

About this time, Mr. Rice, the president of the company, was going to Europe to sell boats, and asked my opinion as to where his market lay. With impressive accentuation and a perfectly good line of reasoning, I clearly showed him that he should keep away from Great Britain, since her policy must be to exert all her naval prestige to hold back the development of submarines; that the submarine was the arm of weak navies and that therefore he should seek his market in the small countries.

He went to England, remained there two or three months, investigated no other market, and came back with an order for five boats for the British Admiralty.

My very exact knowledge of foreign naval policies must have had a kink in it somewhere.

However, the German navy at this period was dead sure that submarines were impracticable, dangerous and useless. A Counselor of the German Empire, who was a naval architect by trade, read a paper before the Society of Naval Architects in Berlin or Kiel, wherein he showed that if, when submerged, a submarine from movements of crew or other weights, became down by the head a bit, she was bound to go down and down until the pressure of water squeezed her flat and removed all thickness dimensions from the bodies of her wretched crew.

The *Holland* was trimmed a few degrees by the head and Captain Cable held her, on a run, within a foot of the desired depth.

The German scientist forgot diving-rudder effect and the stability of motion, which, in the light of what Germans did with submarines in the war of the German aggression, seems a bit curious.

During the term of the Naval War College at Newport following my testifying before the

Senate Naval Committee, there was much discussion of the usefulness of submarines. In lectures, I very clearly, and most satisfactorily to myself, showed their great tactical and strategic value and asserted the dogma that in the presence of efficient submarines the then legal blockades could not exist; that a boat capable of movement in three dimensions possessed certain great advantages over craft moving in only two dimensions.

Other officers, in lectures, demonstrated that things were quite the other way about and that efficient submarines could never exist.

For me, the obvious was about to happen. While I had been given perfect freedom to express my opinions before the Senate Naval Committee, it was irritating to the three chiefs of bureaus, whom I had directly contradicted, to have such opinions lying about, especially as there seemed to be some connection between these opinions and an appropriation for utterly undesired submarines.

A dear old shipmate expressed the thought that what was coming to me for making myself a nuisance as a submarine crank was bound to come. It was.

And so, in 1901, on Christmas Eve, when the home influences are so sweet, I found myself boarding a ship and headed for the fair South Seas, where I could commune with the beauties of nature and ponder upon the unwisdom of kicking against the pricks of superior authority.

After seventeen years of futile fussing with the development of submarines and just as real development was beginning, my connection with it fell with a dull, sickening thud. It was all in the day's work in our service.

Holland was always irritated about the errors in the *Adder* class designs and about 1904 hauled out of the Holland company. He turned his attention to flying. He was one of the first to appreciate the sustension, due to rarefaction on the upper side of wing or plane, and made considerable progress toward practical applications of the principle. For ten years, off and on, in correspondence and at meetings, I worked with him on the flying schemes. Many an hour have I held a stop watch on great gulls, frigate birds, booby birds and albatross, trying to get data for Holland as to how those birds developed rarefaction on the upper sides of their wings. He was delighted with some figures obtained from pelicans. He wished an example of a heavy bird taking the air from rest or from a slow motion of translation, directly from the surface of the water.

The way a pelican gets rarefaction over the wing by cramping the primary feathers and forming a current of air over herself before the lazy thing would try to rise was of the utmost interest to him.

However, he could never find nor design a suitable motor, and when an inventor showed him the design of what seemed to be an efficient motor and a method of producing real rarefaction, Holland said that the methods were superior to his and proceeded to smash his own flying machine with an axe.

During the thirty years in which I knew Holland, I knew him as a man with a wonderful nose for smelling out basic mechanical principles, with a great capacity for practically applying those principles, and with a bulldog tenacity in hanging on and making things work under discouraging conditions.

He was most appreciative, even when one wished to lend him a hand and really did nothing of the sort.

It was this generous appreciativeness that made him write of me to a certain great personage—a writing of which I am the prouder because it is so far from true—"He has done more for submarining than any other living man."

He was a fair fighter, a most interesting and amusing companion, the stanchest of friends.

God rest his soul.

W. W. Kimball

THE END